# Journal of the
# Royal Microscopical Society

CONTAINING ITS TRANSACTIONS AND PROCEEDINGS

AND

A SUMMARY OF CURRENT RESEARCHES RELATING TO

ZOOLOGY AND BOTANY
(principally Invertebrata and Cryptogamia)

MICROSCOPY, &c.

EDITED BY


**R. G. HEBB, M.A. M.D. F.R.C.P.**

WITH THE ASSISTANCE OF THE PUBLICATION COMMITTEE AND

J. ARTHUR THOMSON, M.A. LL.D.
*Regius Professor of Natural History in the University of Aberdeen*

A. N. DISNEY, M.A. B.Sc.

FELLOWS OF THE SOCIETY

AND

A. B. RENDLE, M.A. D.Sc. F.R.S. F.L.S.
*Keeper, Department of Botany, British Museum*

HAROLD MOORE, B.Sc.
*Woolwich Arsenal*

RALPH ST. JOHN BROOKS,
M.A. M.D. D.P.H. D.T.M. & H. (CAMB.)


---

Minimis partibus, per totum Naturæ campum, certitudo omnis innititur
quas qui fugit pariter Naturam fugit.—*Linnæus.*

---

FOR THE YEAR
1916


TO BE OBTAINED AT THE SOCIETY'S ROOMS
20 HANOVER SQUARE, LONDON, W.

OF MESSRS. WILLIAMS & NORGATE, 14 HENRIETTA STREET, LONDON, W.C.
AND OF MESSRS. DULAU & CO., 37 SOHO SQUARE, LONDON, W.

Extra and informal Meetings are held on the 1st and 4th Wednesday evenings of the month. These Meetings are devoted to:—(1) Biology, Bacteriology, and Histology; (2) Microscopical Optics and Microsope Construction.

11141

THE

# Royal Microscopical Society.

Established in 1839. Incorporated by Royal Charter in 1866.

**The Society** was established for the promotion of Microscopical and Biological Science by the communication, discussion, and publication of observations and discoveries relating to (1) improvements in the construction and mode of application of the Microscope, or (2) Biological or other subjects of Microscopical Research.

It consists of Ordinary, Honorary, and Ex-officio Fellows of either sex.

**Ordinary Fellows** are elected on a Certificate of Recommendation signed by three Ordinary Fellows, setting forth the names, residence, and description of the Candidate, of whom the first proposer must have personal knowledge. The certificate is read at two General Meetings, and the Candidate balloted for at the second Meeting.

The Admission Fee is 2*l*. 2*s*., and the Annual Subscription 2*l*. 2*s*., payable on election, and subsequently in advance on 1st January annually. The Annual Subscriptions may be compounded for at any time for 31*l*. 10*s*. Fellows elected at a meeting subsequent to that in February are only called upon for a proportionate part of the first year's subscription. The annual Subscription of Fellows permanently residing abroad is 1*l*. 11*s*. 6*d*., or a reduction of one-fourth.

**Honorary Fellows** (limited to 50), consisting of persons eminent in Microscopical or Biological Science, are elected on the recommendation of five Ordinary Fellows and the approval of the Council.

**Ex-officio Fellows** (limited to 100), consisting of the Presidents for the time being of any Societies having objects in whole or in part similar to those of the Society, are elected on the recommendation of ten Ordinary Fellows and the approval of the Council.

**The Council**, in whom the management of the property and affairs of the Society is vested, is elected annually, and is composed of the President, four Vice-Presidents, Treasurer, two Secretaries, and twelve other Ordinary Fellows.

**The Meetings** are held on the third Wednesday in each month, from October to June, at 20 Hanover Square, W. (commencing at 8 P.M.). Visitors are admitted by the introduction of Fellows. (See preceding page.)

**The Journal**, containing the Transactions and Proceedings of the Society, and a Summary of Current Researches relating to Zoology and Botany (principally Invertebrata and Cryptogamia), Microscopy, etc., is published bi-monthly, and is forwarded post-free to all Ordinary and Ex-officio Fellows residing in countries within the Postal Union.

**The Library**, with the Instruments, Apparatus, and Cabinet of Objects is open for the use of Fellows daily (except Saturdays), from 10 A.M. to 5 P.M. It is closed for four weeks during August and September.

*Forms of proposal for Fellowship, and any further information, may be obtained by application to the Secretaries, or Assistant-Secretary, at the Library of the Society, 20 Hanover Square, W.*

# Patron

HIS MAJESTY THE KING.

# Past-Presidents.

| | Elected |
|---|---|
| *Sir Richard Owen, K.C.B. D.C.L. M.D. LL.D. F.R.S. | 1840–1 |
| *John Lindley, Ph.D. F.R.S. | 1842–3 |
| *Thomas Bell, F.R.S. | 1844–5 |
| *James Scott Bowerbank, LL.D. F.R.S. | 1846–7 |
| *George Busk, F.R.S. | 1848–9 |
| *Arthur Farre, M.D. F.R.S. | 1850–1 |
| *George Jackson, M.R.C.S. | 1852–3 |
| *William Benjamin Carpenter, C.B. M.D. LL.D. F.R.S. | 1854–5 |
| *George Shadbolt | 1856–7 |
| *Edwin Lankester, M.D. LL.D. F.R.S. | 1858–9 |
| *John Thomas Quekett, F.R.S. | 1860 |
| *Robert James Farrants, F.R.C.S. | 1861–2 |
| *Charles Brooke, M.A. F.R.S. | 1863–4 |
| *James Glaisher, F.R.S. | 1865–6–7–8 |
| *Rev. Joseph Bancroft Reade, M.A. F.R.S. | 1869–70 |
| *William Kitchen Parker, F.R.S. | 1871–2 |
| *Charles Brooke, M.A. F.R.S. | 1873–4 |
| *Henry Clifton Sorby, LL.D. F.R.S. | 1875–6–7 |
| *Henry James Slack, F.G.S. | 1878 |
| *Lionel S. Beale, M.B. F.R.C.P. F.R.S. | 1879–80 |
| *Peter Martin Duncan, M.B. F.R.S. | 1881–2–3 |
| *Rev. William Hy. Dallinger, M.A. LL.D. F.R.S. | 1884–5–6–7 |
| *Charles Thos. Hudson, M.A. LL.D. (Cantab.), F.R.S. | 1888–9–90 |
| Robert Braithwaite, M.D. M.R.C.S. | 1891–2 |
| Albert D. Michael, F.L.S. | 1893–4–5–6 |
| Edward Milles Nelson | 1897–8–9 |
| William Carruthers, F.R.S. F.L.S. F.G.S. | 1900–1 |
| Henry Woodward, LL.D. F.R.S. F.G.S. F.Z.S. | 1902–3 |
| Dukinfield Hy. Scott, M.A. Ph.D. LL.D. F.R.S. F.L.S. | 1904–5–6 |
| *The Right Hon. Lord Avebury, P.C. D.C.L. LL.D. F.R.S., etc. | 1907–8 |
| Sir Edwin Ray Lankester, K.C.B. M.A. LL.D. F.R.S. F.L.S. F.Z.S. | 1909 |
| J. Arthur Thomson, M.A. F.R.S.E. | 1910–11 |
| Henry George Plimmer, F.R.S., F.L.S., F.Z.S., etc. | 1911–12 |
| G. Sims Woodhead, M.A. M.D. LL.D. F.R.S.E., etc. | 1913–16 |

* Deceased.

# COUNCIL.

Elected 21st January, 1916.

## President.

Edward Heron-Allen, F.L.S. F.Z.S. F.G.S. M.R.I.A., etc.

## Vice-Presidents.

Joseph E. Barnard.
*Arthur Earland.
John Hopkinson, F.L.S. F.G.S. F.Z.S.
F. Shillington Scales, M.A. M.D., etc.

## Treasurer.

*Cyril F. Hill.

## Secretaries.

*J. W. H. Eyre, M.D. F.R.S.E., etc.
*David J. Scourfield, F.Z.S.

## Ordinary Members of Council.

H. F. Angus.
*Alfred N. Disney, M.A. B.Sc.
*R. G. Hebb, M.A. M.D. F.R.C.P.
R. Tanner Hewlett, M.D., F.R.C.P.
J. Milton Offord.
Robert Paulson, F.L.S.
Percy E. Radley.
Charles F. Rousselet.
Edward J. Sheppard.
Charles D. Soar, F.L.S.
Joseph Wilson.

* Members of the Publication Committee.

**EDITOR.**

R. G. Hebb, M.A. M.D. F.R.C.P.

**LIBRARIAN.**

Percy E. Radley.

**CURATORS.**

Edward J. Sheppard. | Charles Singer, M.A. M.D., etc.

**ASSISTANT SECRETARY.**

A. E. Bull.

# CONTENTS.

## *TRANSACTIONS OF THE SOCIETY.*

## *OBITUARIES.*



## *SUMMARY OF CURRENT RESEARCHES.*

### ZOOLOGY.

### VERTEBRATA.

#### *a.* Embryology.

### *b.* Histology

### c. General.

### Tunicata.



## INVERTEBRATA.

### Mollusca.



#### α. Cephalopoda.



#### γ. Gastropoda.



#### δ. Lamellibranchiata.



### Arthropoda.

#### α. Insecta.

## β. Myriopoda.



## δ. Arachnida.

## ε. Crustacea.



## Annulata.

## Nematohelminthes.



## Platyhelminthes.

## Incertæ Sedis.



## Rotatoria.



## Echinoderma.

## Cœlentera.



## Porifera.



## Protozoa.

# BOTANY.

## GENERAL,

### Including the Anatomy and Physiology of Seed Plants.

### Cytology,

#### Including Cell-contents.



### Structure and Development.

#### Vegetative.



#### Reproductive.

### Vegetative and Reproductive.



### General.



## CRYPTOGAMS.

### Pteridophyta.



### Bryophyta.

## Thallophyta.

### Algæ.

## Fungi.

## Lichens.

## Mycetozoa.



## Schizophyta.

### Schizomycetes.

# MICROSCOPY.

## A. Instruments, Accessories, etc.

### (1) Stands.



### (3) Illuminating and other Apparatus.



### (4) Photomicrography.



### (5) Microscopical Optics and Manipulation.

### (6) Miscellaneous.



## B. Technique.

### (1) Collecting Objects, including Culture Processes.

(2) Preparing Objects.



(3) Cutting, including Embedding and Microtomes.



(4) Staining and Injecting.



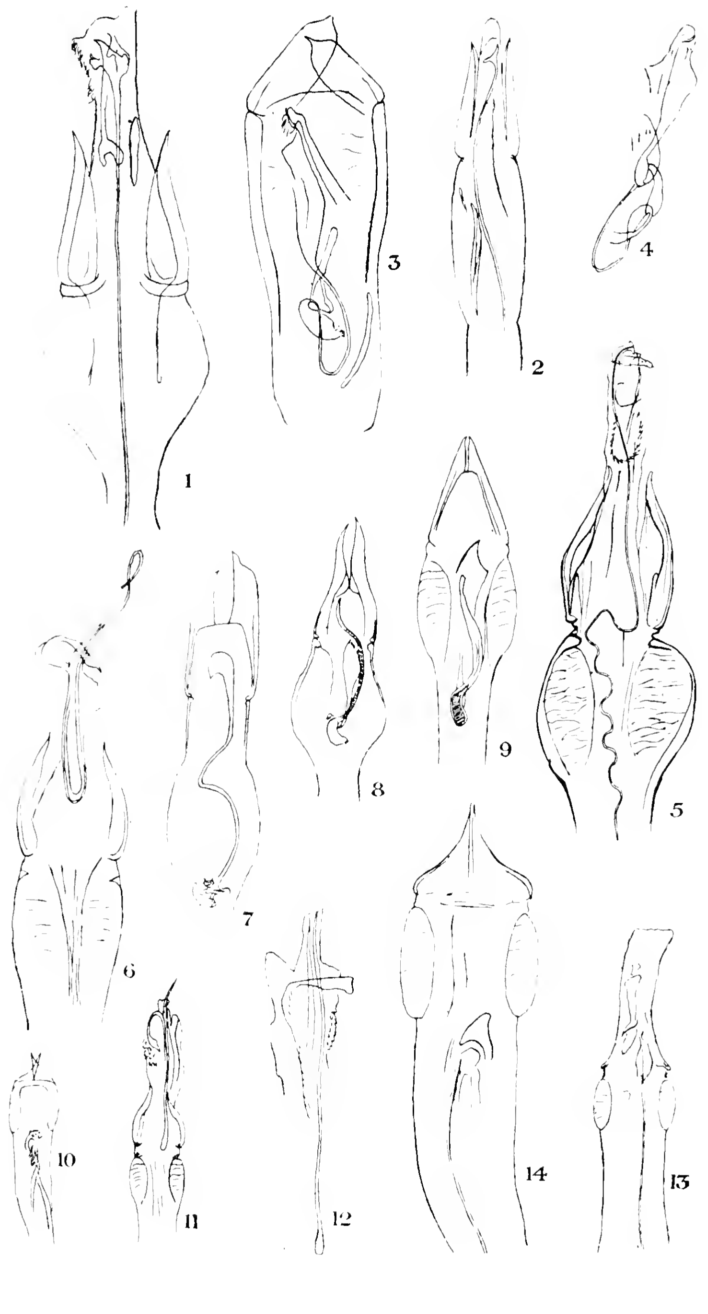
(5) Mounting, including Slides, Preservative Fluids, etc.

### (6) Miscellaneous.



## Metallography, etc.

## *PROCEEDINGS OF THE SOCIETY.*


1
2
3
4
5
6
7
8
9
10
11
12
13
14

# JOURNAL

OF THE

# ROYAL MICROSCOPICAL SOCIETY.

FEBRUARY, 1916.


## TRANSACTIONS OF THE SOCIETY.

### I.—*On the Male Genital Armature of the Dermaptera. Part III.: Eudermaptera.*


By Malcolm Burr, M.A. D.Sc. F.L.S. F.E.S.

*Communicated by* John Hopkinson, V.-P. R.M.S. (*Read May* 19, 1915.)


Plates I to IV.

## EUDERMAPTERA.

This is the higher section of the *Dermaptera* proper. Here we find a more compact body, reduced opisthomeres, and a single penis, which last feature sharply differentiates it from the more primitive *Protodermaptera*.

We find a greater variety of external structure, but greater uniformity in the genitalia. At the same time, the subdivisions are far less sharply marked, and for distinguishing features we are driven more and more to purely sexual characters, the form and armature of the forceps, the spines of the abdomen, and keels of the elytra for our characters. The number of genera containing few species becomes multiplied, but yet we are confronted with a much more uniform structure of the male genitalia than in the

EXPLANATION OF PLATE I.

FIG.
1. *Nesogaster ruficeps* Erichs.
2. *Irdex nitidipennis* Borm.
3. *Marava doddi* Burr.
4. Ditto.
5. *Spongovostox ruber* Bor.
6. *S. conradti* Burr.
7. *Chætospania pittarellii* Bor.

FIG.
8. *Chætospania stiletta* Burr.
9. *Homotages feæ* Borm.
10. *Spongovostox quadrimaculatus* Stål.
11. *S. assiniensis* Borm.
12. Ditto.
13. *S. tripunctatus* Bor.
14. *S. schläferi* Burr.

*Protodermaptera.* As Zacher truly remarks, in the lower group the greater diversity of form in the genital organs but represents Nature's attempts at the best type, which we find in the more highly developed section in the reduction of the proparameres, the disappearance of one penis with its concomitant appendages. The uniformity of the structure of the body and of the genitalia are clearly correlated, as Zacher observes, and consequently the reproductive organs are less useful to the systematist than in the Protodermaptera.

Zacher opened the discussion on this group in a paper entitled "Das männliche Copulationsorgan und das System der Eudermaptera." * He agrees with my half-formed wish to connect the *Chelisochidæ* with the *Labiidæ*. He suggests that the *Sparattinæ* and *Spongiphorinæ*, both mainly Neotropical groups, form the link between the two, and quotes my own opinion that *Auchenomus* represents the passage between the *Sparattinæ* and the *Chelisochinæ*. Earlier authors placed *Auchenomus* in the latter group, I do so in the former. It is premature to express a final opinion, since the genitalia of but a few species have been examined, but it is noticeable that both in the *Labiidæ* and in the *Chelisochidæ* a posteriorly widened pronotum is very common. Possibly this character has more significance than we are yet aware of, but though of apparently no very great importance, it is an undoubted fact that both in the *Labiidæ* and in the *Chelisochidæ* this shaped pronotum is very common. As a character we may compare it with the keels on the femora of most of the *Pygidicranidæ*, which is a more valuable character than would appear at first sight. Probably there is a phylogenetic origin to each, and convergence is not the cause.

I quite agree to Zacher's proposal to divide the Eudermaptera into two main groups, the *Labiidæ* and *Chelisochidæ* on the one hand, and the *Forficulinæ* and remaining subfamilies on the other.

The Eudermaptera, or higher Earwigs, are sharply distinguished from the lower group, or Protodermaptera, by the possession of a single penis: there is but one præputial sac, or penis proper, with a single virga and ejaculatory duct. The proparameres are also reduced, being but feebly chitinized, so that it is difficult to say which is the true base of the segment, and the hinge is far less well-marked than in the lower group, though always better chitinized than the rest of the structure. In erection, the præputial sac is protruded between the metaparameres, which, as a rule, do not seem to alter their position, but in my preparation of *Opisthocosmia* (?) *pœcilocera* Borg. and *Mesochelidura bolivari* Dubr. they are opened outwards, moving more or less freely about the hinge, though less freely than in the Protodermaptera.

* Zeitchr. wiss. Insektenbiol., viii. (1912) p. 276.

We find a far smaller diversity of form than in the Protodermaptera; the metaparameres are of two main types, one more or less acuminate (*Labiinæ*, *Chelisochinæ*), the other with rounded tips (*Opisthocosmiinæ*, *Anechurinæ*, *Forficulinæ*). The virga and reniform vesicle offer useful characters, but more of specific than of generic value. The length of the virga seems to be a useful character in the *Forficulinæ* and *Opisthocosmiinæ*, but I always have a feeling of doubt that this may be an elastic feature, and that the virga is capable of considerable extension in erection.

In all instances that I have examined, the manubrium is short and small, about half as broad as long, and rounded at the tip.

## FAMILY LABIIDÆ.

In accepting Zacher's definite proposal to reduce the Chelisochidæ to the rank of a subfamily of the *Labiidæ*, the inclusion of *Pericomus* Burr, *Vandex* Burr, *Strongylopsalis* Burr, and *Nesogaster* Verh., into either the *Labiinæ* or *Spongophorinæ*, follows; they are very well-marked genera, but cannot be given the same rank as the *Chelisochinæ*. It is tempting to think that we may be able to define the *Labiinæ* as an Old World, the *Sponiphorinæ* as a New World group, but we must be careful not to stretch our facts to suit our theories.

### Subfamily LABIINÆ.

Zacher briefly refers to the *Labiinæ*, *Sparattinæ*, and *Spongiphorinæ*, but I am unable to make much use of his work in this respect, as he fails to figure any of the last group, and I have no material as yet available. Zacher states that the parameres resemble those of the preceding groups, that the virga is typical and very long, and that there is a hairy field in the præputial sac.

As to his *Sparattinæ*, we must eliminate his "*Sparatta* sp." from the Kamerun (his fig. 2), as the *Sparattinæ* are an exclusively Neotropical group. His fig. 20, "*Sparatta* sp.," also from the Kamerun, is subject to the same criticism. These two evidently are related to *Chætospania* or *Spongovostox*, as we shall presently see.

His fig. 1 is called *Parasparatta schotti*. I question the accuracy of the identification, as this species is only known from the original type of Dohrn, which is a female, in the Vienna Museum. His specimen is, however, probably a true Brazilian *Sparatta*, though he refers to no locality. The genitalia resemble those figured by Borelli of *Metasparatta chacoensis* Bor., with characteristic narrow and acuminate and slightly recurved metapara-

meres, with long virga, and various indistinct chitinous plates in the præputial sac.

Zacher does not figure, but describes the genitalia of *Mecomera* sp., from Brazil. If it is a true *Mecomera*, it is most probably *M. brunnea* Serv., the only known species. It appears to have the complex armature of the præputial sac which is so common a feature in the Labiidæ.

I will now discuss a few species the genitalia of which have not yet been described. I have only examined the manubrium in two species—in *Irdex nitidipennis* and *Chætospania pittarellii*—in both it is longer than broad, gently narrowed, and rounded at the tip.

*Irdex nitidipennis* Borm.

Typical lanceolate metaparameres; virga more than twice as long as the metaparameres, bilobed at the apex, with no discernible basal vesicle, and one or two long and narrow chitin-plates in the præputial sac (Pl. I, fig. 2).

*Nesogaster ruficeps* Erichs.

Metaparameres rather broad at base, lanceolate and recurved; virga very long and straight, no basal vesicle discernible, terminating apically in a complex dilated chitin-structure, with one or two plates, and one spanner-shaped plate (Pl. I, fig. 1).

*Marava doddi* Burr.

Metaparameres broad and parallel-sided, abruptly narrowed and acute at the tips; virga with very feebly chitinized basal vesicle, then curved in the form of a U, opening into an inflated chitinous area, with an elongate, apically dilated, narrow chitin-plate (Pl. I, figs. 3 and 4).

*Spongovostox ruber* Bor.

Metaparameres narrow, acuminate and recurved at the tips; proparameres with spongy dilations; virga very long, about four times as long as the metaparameres, undulated in basal portion; præputial sac with round denticulate plate.

The specimen is from the Kamerun, and is in erection (Pl. I, fig. 5).

*Spongovostox conradti* Burr.

Metaparameres narrow and recurved, acuminate, but no spongy dilatation; virga very long, undulate and coiled, with hooked chitinous basal armature (Pl. I, fig. 6).

### *Chætospania pittarellii* Bor.

Metaparameres broad and parallel-sided, abruptly narrowed at the tips by the sinuation of the outer margin, the inner margin straight; virga long, with feeble basal vesicle and small chitin-plates, inflated at apex; one metaparamere decidedly shorter than the other (Pl. I, fig. 7).

### *Chætospania stiletta* Burr. (S. India.)

Metaparameres narrow, sinuate, and acute; virga only a little longer than the metaparameres, with basal vesicle (Pl. I, fig. 8).

### *Homotages feæ* Borm. (N. India.)

Metaparameres straight-sided, narrow, incurved and acute at the tips; sides of proparameres with spongy dilation; virga short, rather broad, with basal vesicle, terminating apically in a broad, curved chitinous triangular tooth (Pl. I, fig. 9).

It is very interesting to note that the examination of the genitalia leads us to place this genus definitely in the Labiidæ. On account of the shape of the forceps, de Bormans originally placed it in the genus *Anechura*, since when it has wandered about in the *Chelisochinæ* and *Forficulinæ*; the non-dilated, simple and elongate second tarsal segment should have warned me against that error. The tarsi have the row of stiff bristles along the side of the basal segment, as in *Chætospania*, and the posteriorly dilated pronotum is of a type which is predominant in the *Chelisochinæ* and *Labiinæ*. The general form of the genitalia recalls that of the South Indian *Chætospania stiletta.*

### *Spongovostox assiniensis* Borm.

My mount, from a Kamerun specimen, is in erection, but being rather heavily stained, the structure is rather obscure. The metaparameres recall those of *S. ruber*, but the absence of the lateral sponges of the proparameres is noteworthy; the virga seems to be moderately long, and is straight; in the præputial sac there is a broad and hooked chitin-plate (Pl. I, figs. 11 and 12).

### *Spongovostox tripunctatus* Bor.

Metaparameres broad at base, rapidly narrowing by the concavity of the external margin, acute; proparameres with sponges; virga 2–3 times longer than metaparameres, straight, with a series of chitin-plates in the præputial sac.

My specimen is from Kamerun, and is in erection (Pl. I, fig. 13).

*Spongovostox schläferi* Burr.

Generally resembles the preceding species, apparently offering differences only in the form of the chitin-plates (Pl. I, fig. 14).

*Spongovostox* sp. ("*Sparatta* sp." of Zacher, Zacher's Fig. 2.)

The specimen is from Kamerun, but only the apical portion is shown, but, from his silence, the sponges are probably absent. The externally concave, acute metaparameres are typical of the group; the præputial sac is a small series of denticulations; the ductus ejaculatorius ends in a dilated chitin-plate.

*Spongovostox* sp. (Zacher's "*Sparatta* sp.," Fig. 20, from Kamerun.)

The form of the parameres and the presence of the sponges recall *S. ruber*, the metaparameres being narrow and recurved; the virga is not shown.

*Spongovostox quadrimaculatus* Stål. (Specimen from Entebbe.)

Metaparameres very broad at base, and inner margin straight, but rapidly narrowing by concavity of outer margin; tips acute; virga long, with fibrous chitinous armature, and a fine denticulate pad near the apex; spongiform structures weakly developed, but distinctly visible (Pl. I, fig. 10).

*Labia curvicauda* Motsch.

Unfortunately, the only specimen which I have mounted is somewhat damaged, and the structure obscure. It is in erection, the end of the virga extending far beyond the præputial sac, the armature of which I am unable to discern. One metaparamere is broken, but the other is a typical, narrow, acuminate, slightly sinuous plate; the hinge is very weak (Pl. II, fig. 1).

*Labia marginalis* Thunb.

Here the metaparameres are narrow and lanceolate, gently incurved at the tips; the virga is very long, nearly four times as long as the metaparameres, tapering at each end, and broader in the middle; at the base there appears to be a dilated thin chitinous plate, and a series of minute denticulations. There are no lateral sponges (Pl. II, fig. 2).

*Chætospania thoracica* Dohrn.

Metaparameres broadest in the middle, abruptly attenuate at the apex, the right side more dilated about the middle than the left. The virga is sinuate, not very long, rather dilated towards the base, the end of the ejaculatory duct being distinct in my specimen; near the apex of the virga are a number of minute spots which appear to be glands or cellular nuclei (Pl. II, fig. 3).

*Chætospania australica* Borm.

Metaparameres narrow, lanceolate, of equal width, subsinuate; proparameres with no spongy dilations; virga nearly straight, long, with complex chitin-armature at base (Pl. II, fig. 4).

*Prolabia unidentata* Beauv.

This specimen, from Cuba, has the metaparameres of a Forficuline type, that is, long and straight, almost parallel-sided, and rounded at the tips; the lateral spongiform areas are distinct; the virga is bent at the base and surrounded with a faint spiral structure like a trachea; the præputial sac is entirely filled with a dense, fibrous, denticulate armature (Pl. II, fig. 5, *a* and *b*).

In general, one of the chief features of the Labiine genitalia is the acuteness of the metaparameres. These are of eight types.

1. Broad at base, the inner margin straight, but outer margin strongly concave (*Spongovostox schläferi* and *S. tripunctata*).

2. Narrow, the outer margin sinuous, and tips recurved (*S. ruber*, and fig. 20 of Zacher, *S. assiniensis*, *S. conradti*, *Nesogaster ruficeps*).

3. Narrow, and straight (*Irdex nitidipennis*, *Chætospania australica*, *Labia marginalis*).

4. Inner margin straight, broad, and parallel-sided nearly to tip, then abruptly narrowed by concavity of outer margin (*C. pittarellii*).

5. Narrow, both margins sinuate (*C. stiletta*).

6. Broad at base, tapering, the sides straight (*Homotages feæ*).

7. Broad and parallel-sided, abruptly but symmetrically narrowed and acuminate at tip (*Marava doddi*, *C. thoracica*).

8. Narrow, external margin concave, recurved (*Metasparatta chaconsis*, "*Parasparatta schotti*" of Zacher).

Probably a greater diversity of form will be shown when further material is examined.

The virga is of several forms.

A. Without basal vesicle.

1. Quite simple, very long (*Spongorostox ruber*).
2. Similar, but ending in a dilated chitin-plate (*Nesogaster ruficeps*, and perhaps in *S. assiniensis*, *S. tripunctata*, *S. schläferi*, *S. conradti*, *Irdex nitidipennis*, *Labia marginalis*, *Chætospania australica*).

B. With basal vesicle.

1. Much longer than metaparameres, undulate or coiled, terminating in dilated chitin-plate (*Marava doddi*, *C. pittarellii*).
2. Scarcely longer than metaparameres.
   - *a*. Terminating in broad chitinous triangular plate (*Homotages fex*).
   - *β*. Apex simple (*C. stiletta*, *C. thoracica*).

The proparameres have a curious spongy dilation in the following:—*Homotages fex*, *Spongorostox schläferi*, *S. tripunctata*, *S. ruber*.

The præputial sac is denticulate in the following:—*Spongorostox ruber*, *Spongorostox* sp. (fig. 20 of Zacher), *Labia marginalis*.

The most striking feature is the complexity of the armature of the præputial sac, with the frequent and very varied shapes of the chitin-plates and dilations of the virga.

It is premature to generalize further on this group, or to suggest any modification, or even the confirmation, of the existing system.

## Subfamily Chelisochinæ.

I quite agree with Zacher's opinion that this group is closely related to the Labiidæ, an opinion which, as he remarks, I had already indicated in an earlier work. The fact that the metaparameres are acuminate in every known species is striking; in many instances they closely resemble some Labiine parameres, as will be at once seen from the figures.

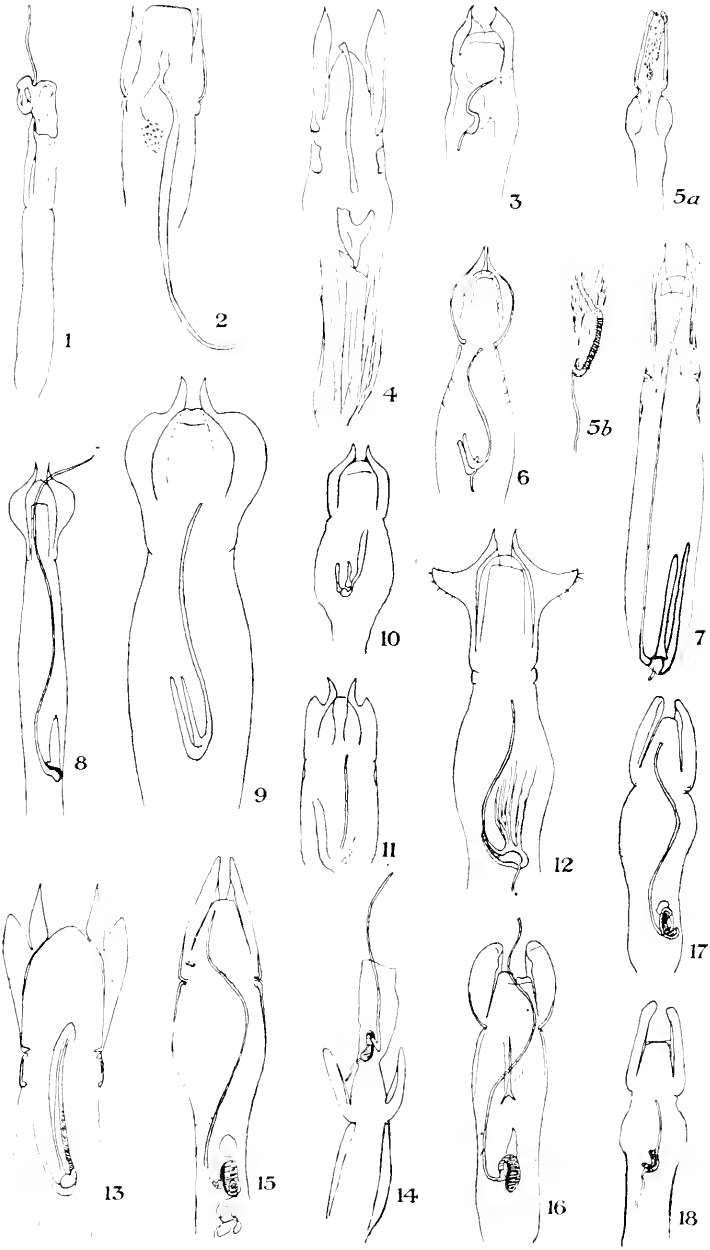
The virga, however, approaches the Forficuline form. It is

---

### EXPLANATION OF PLATE II.

FIG.
1. *Labia curvicauda* Motsch.
2. *L. marginalis* Thumb.
3. *Chætospania thoracica* Dohrn.
4. *C. australica* Borm.
5*a*. *Prolabia unidentata* Beauv.
5*b*. Ditto.
6. *Chelisoches morio* Fabr.
7. *Adiathetus tenebrator* Kirby.
8. *Proreus simulans* Stål.
9. *Kinesis monnseyi* Burr.

FIG.
10. *Enkrates flavipennis* Fabr.
11. *Proreus delicatulus* Burr.
12. *Hamaxas nigrorufus* Burr.
13. *Chelisoches ritsemæ* Burr.
14. *Lesochelidura bolivari* Dubr.
15. *Anechura bipunctata* Fabr.
16. *Allodahlia scabriuscula* Serv.
17. *Anechura harmaudin* Burr.
18. *Burriola euxina* Serv.


1
2
3
5a
4
6
5b
7
8
9
10
11
12
17
13
15
14
16
18

much simpler than in the Labiidæ, and shorter. The complex chitin structures are wanting. The basal vesicle is usually present, but weakly developed; but the virga has one or two narrow chitin-lobes at the base.

The metaparameres offer considerable variety of form, tending to exaggeration in *Chelisoches ritsemæ* and *Hamaxas nigrorufus*. The manubrium in *C. morio* is longer than broad, gently narrowed, and rounded at the tip.

*Adiathetus tenebrator* Kirby. (S. India.)

Metaparameres narrow, and gently sinuate; virga nearly three times as long as the metaparameres, with scarcely dilated basal vesicle, and two narrow chitin-lobes as long as the metaparameres.

The virga agrees with *A. shelfordi* (Borneo) as figured by Zacher, but the metaparameres are somewhat different (see fig. 3 of Zacher) (Pl. II, fig. 7).

*Proreus simulans* Stål.

This is certainly the species figured by Zacher (fig. 7) as *Proreus* sp., from Matupi. The metaparameres are bowed, dilated externally in the middle. The virga is very long, nearly four times as long as the metaparameres, with a single chitin-lobe at the base (Pl. II, fig. 8).

*Kinesis mounseyi* Burr.

The metaparameres resemble those of *P. simulans*, but the virga is less than twice as long as the metaparameres, and has two chitin-lobes at the base (Pl. II, fig. 9).

*Chelisoches morio* Fabr.

The metaparameres are of the same form as in the two preceding species, but the dilation is less pronounced; my specimens show it more strongly than Zacher's figure. The virga is short, with two chitin-lobes, and resembles that of *K. mounseyi*.

Zacher figures *Proreus fuscipennis* (? identity) and *Kleiduchus australicus*, both of which are similar in design to *Adiathetus* and *Proreus* (Pl. II, fig. 6).

*Enkrates flavipennis* Fabr.

Here, again, we have the same type, both of paramere and of virga; the latter is quite short, with two short chitin-lobes, and feeble vesicle (Pl. II, fig. 10).

We now come to a type, or rather a group of types, of metaparameres that appears to be essentially different, being far more complex than those so far mentioned. But a little consideration will show how the external bulging so marked in *C. morio*, *P. fuscipennis*, *P. simulans*, etc., by exaggeration may develop into the three remarkable forms following.

*Proreus delicatulus* Burr. (N. India.)

The metaparameres are rather broad; on the external margin near the apex there is a strong emargination, which has the effect of leaving a short, broad, triangular external lobe, and an inner, narrow, recurved, acute internal lobe.

The virga is not very long, and there appears to be only one chitin-lobe to the virga (Pl. II, fig. 11).

*Chelisoches ritsemæ* Borm.

Here the emargination of the metaparameres is carried still further, and takes the form of a deep incision, forming two lobes. The basal one is broad, narrowed at the apex to a blunt point; the inner lobe is longer, and much narrower, regularly tapering to an acute point. The virga is not much longer than the metaparameres, and strengthened by a long narrow chitin-plate. The basal vesicle is rather more developed than usual in this group, with the spiral structure quite clear upon the basal portion of the virga; it is provided with one long chitin-lobe (Pl. II, fig. 13).

*Hamaxas nigrorufus* Burr. (New Guinea.)

Here we have a very remarkable form of metaparamere. Instead of two lobes being formed by an external incision, we have the tendency to external dilation carried to an extreme, forming a broad lateral lobe half as wide as the whole segment is long; the posterior margin is convex, the anterior concave, the tip acute; there are a few tufts of bristles on the posterior margin near the tip, and on the anterior margin a few minute irregularities of outline that have the appearance of papillæ. Anterior to these lateral lobes, the margin is strongly concave, the segments terminating in a strongly-narrowed acute point (Pl. II, fig. 12).

The virga is not much longer than the metaparameres; the basal vesicle is well developed, and spiral structure is seen in the lower part of the virga. A striated chitin-plate, very broad and ill-defined, departs from the upper side of the vesicle.

In the structure of the virga, with the gradual development of the basal vesicle from the scarcely dilated end of the virga in

*Chelisoches morio*, to the well-defined reniform vesicle of *Hamaxas nigrorufus*, we have an approach to the Forficuline type.

The usually well-defined, long and narrow, horny chitinous lobes attached to the vesicle are characteristic of the group, as well as the tendency to lateral foliation and external emargination of the metaparameres, culminating in the highly ornate forms seen in *Chelisoches ritsemæ* and *Hamaxas nigrorufus*.

It is yet, however, premature to say whether the study of the genitalia will modify the existing system of the family.

## Family FORFICULIDÆ.

Zacher has shown that the *Anechurinæ*, *Forficulinæ*, and *Opisthocosmiinæ* all have a very similar type of genital armature. Characteristic of the group are the almost invariably elongate, apically rounded metaparameres, well-developed reniform basal vesicle of the virga, sometimes with chitinous appendages, and nearly straight or gently sinuous virga of varying length. Useful characters are afforded by the manner in which the virga is connected with the vesicle. Sometimes it enters with no appreciable angle, sometimes it is strongly elbowed. The vesicle itself is almost truly reniform, and its appendages offer some diversity of form.

In the *Anechurinæ*, the virga appears to be always elbowed at the junction with the vesicle. This is well seen in Zacher's figures of *Burriola euxina* Sem., *Burriola reiseri* Wern., *Mesochelidura bolivari* Dubr., and *Chelidura acanthopygia* Géné. It is also very noticeable in the accompanying figures of *Anechura bipunctata* Fabr., and *Allodahlia scabriuscula* Serv.

As a rule, the metaparameres are rather narrow, as in Zacher's figures of *Mesochelidura bolivari*, *Anechura bipunctata*, and *Burriola euxina*, where they are nearly parallel-sided, and apically rounded. In *Allodahlia scabriuscula* they are, however, decidedly roundly convex externally, broad, and broadly rounded at the tips (Pl. II, fig. 16). This species also shows an appendage to the vesicle and a narrow chitin-plate in the præputial sac. A somewhat similar appendage to the vesicle is seen in Zacher's figures of other *Anechurinæ*, except *A. bipunctata*, but my figure shows a rather feebly-developed and indistinct appendage. No chitin-plates are recorded in the præputial sac, except in *Allodahlia scabriuscula*.

### Subfamily Anechurinæ.

My inclination to unite the *Chelidurinæ* with the *Anechurinæ* is justified by the genitalia. After all, the reduction of the elytra

is really the only character which has separated the two groups, and this is inadequate.

In the *Anechurinæ*, in the broader sense, as in most of the *Forficulinæ*, *Opisthocosmiinæ*, and probably in the remaining allied genera, the metaparameres are parallel-sided, narrow, and apically rounded.

The most important feature in this group is the reniform vesicle of the virga. We find every gradation from the simple vesicle, with direct junction, in *Isolabella*, to the complex structure of *Chelidurella*, with its abruptly-elbowed virga, and strong and large chitin-plates. The genitalia offer no particular distinction from those of the *Forficulinæ*. In *Burriola euxina* Serv. the metaparameres are typically Forficuline; virga barely twice as long as reniform vesicle, which is reinforced on the concave side by two chitin-lobes (Pl. II, fig. 18).

## Subfamily Forficulinæ.

I can find no character in the genitalia confirming the separation of these two intimately-related groups, and fully confirm Zacher's observation as to the close relation between them and the *Anechurinæ*.

We find the metaparameres generally more or less parallel-sided, simple, long, and rounded at the apex; the virga is of very varying length, invariably provided with a reniform basal vesicle, usually armed with chitin-plates of varying size and design.

In *Apterygida cavalli* Bor. the manubrium is longer than broad, narrowed apically, and rounded at the tip. In *F. auricularia* L. it is similar, but a little shorter, broader, and less rounded at the tip.

### *Chelidurella acanthopygia* Géné.

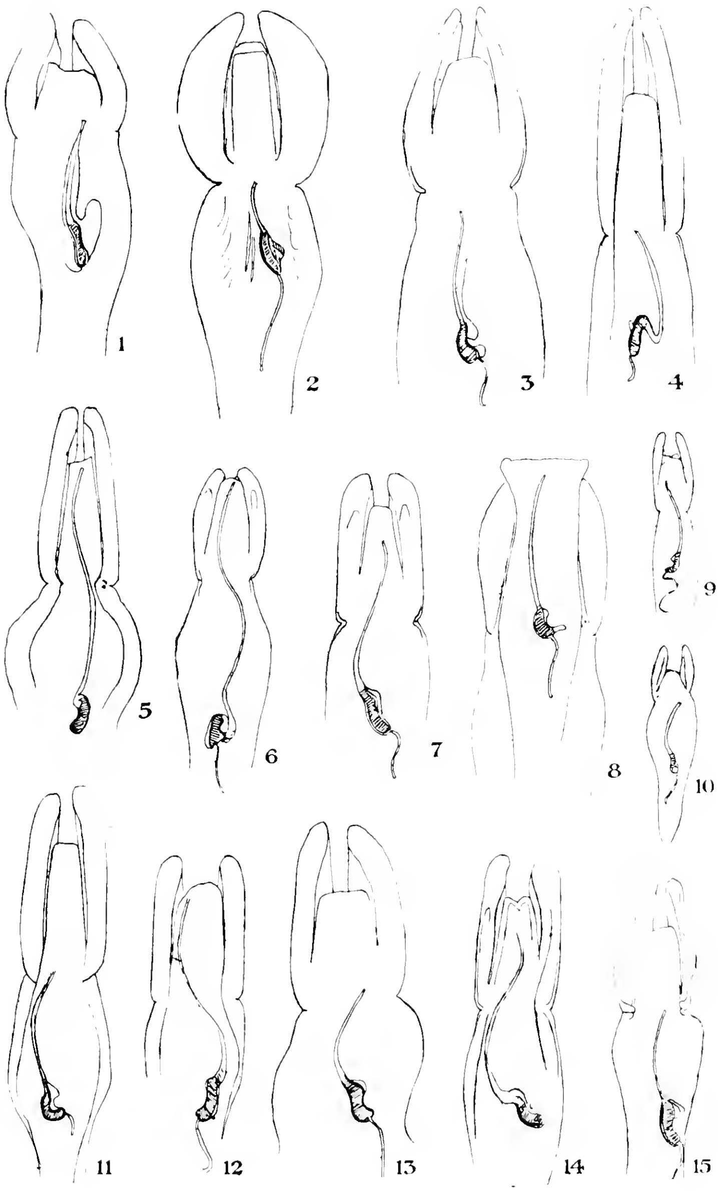
Vesicle figured by Zacher, fig. 12, who describes the genitalia as of the highest and most complex type in the Eudermaptera. The virga is doubled back on itself at the junction, and there is a broad and irregular chitin-plate.

---

## EXPLANATION OF PLATE III.

FIG.
1. *Skalistes lugubris* Dohrn.
2. *Doru lineare* Esch.
3. *D. luteipenne* Serv.
4. *D. bimaculatum* Beauv.
5. *Elaunon bipartitus* Kirby.
6. *Hypurgus humeralis* Kirby.
7. *Apterygida albipennis* Meg.
8. *A. cavalli* Bor.

FIG.
9. *Forficula ætolica* Br.
10. *F. sjöstedhi* Burr.
11. *F. lurida* Fisch.
12. *F. pubescens* Géné.
13. *F. auricularia* L.
14. *F. lesnei* Finot.
15. *F. senagalensis* Serv.


1
2
3
4
5
6
7
8
9
10
11
12
13
14
15

### *Skalistes lugubris* Dohrn.

The metaparameres are more or less crescent-shaped, the virga very short, entering the vesicle without angle; the vesicle is feebly dilated, and protracted by a broad, rounded chitinous lobe. It thus approaches *Doru lineare* rather than *Forficula* in form (Pl. III, fig. 1).

### *Doru lineare* Esch.

Metaparameres broad and crescent-shaped, narrowed towards the tips; virga scarcely longer than the vesicle, which it enters without angle; there is a pair of narrow chitin-plates in the præputial sac, and a small chitin-lobe in the vesicle (Pl. III, fig. 2).

Zacher remarks that in this species the metaparameres depart somewhat from the Forficuline type; but I am inclined to think that his specimen should be referred to the following species, as a comparison of the figures shows at once that in *D. lineare* the metaparameres are much broader and less acute than figured by him.

### *Doru luteipenne* Serv.

My figure agrees well enough with fig. 14 of Zacher, which he attributes to *D. lineare*. The metaparameres are distinctly convex externally, but not so truly crescent-shaped as in *D. lineare*.

The virga is of medium length, and the lower part has a long narrow chitin-plate; the virga enters the vesicle almost without angle, and the latter has a small round chitin-lobe (Pl. III. fig. 3).

In the apical narrowing and generally semilunar shape of the metaparameres, the Neotropical species, with *Skalistes lugubris*, offer a common departure from the true Forficuline type.

### *Doru bimaculatum* Beauv.

This species, although known for a century, is rare in collections. The metaparameres depart less from the Forficuline type than in the three preceding species; they are very long, almost parallel-sided, straight, and scarcely narrowed at the apex. The virga is short, but doubly elbowed at the junction with the vesicle, which has a very small chitin-lobe. Except in its length, the virga rather resembles that of *Forficula smyrnensis* (v. fig. 17 of Zacher), while the metaparameres recall rather those of *F. lurida* (Pl. III, fig. 4).

If we judged from the genitalia alone, this species would be placed in *Forficula* rather than in *Doru*.

*Elaunon bipartitus* Kirby.

In the long, straight, parallel-sided metaparameres, and dilated proparameres, this species agrees with *Forficula*. The virga is moderately long, a good deal longer than the metaparameres; it is elbowed at the junction with the vesicle, which has no chitin-lobe. There is nothing in the genitalia to warrant the separation of this species from *Forficula* (Pl. III, fig. 5).

*Hypurgus humeralis* Kirby.

Another typical Forficuline genital armature; metaparameres gently curved, and of equal breadth through their length; virga nearly two and a half times as long as the metaparameres, elbowed at the junction with the vesicle, which has a rounded chitin-plate (Pl. III, fig. 6).

*Apterygida albipennis* Meg.

The genitalia do not differ from those of *Forficula*. Metaparameres straight; virga about as long as the metaparameres, entering the vesicle without angle, the latter with small chitin-plate (Pl. III, fig. 7).

*Apterygida cavalli* Bor.

Only differs from the preceding in the short virga, scarcely as long as the metaparameres, entering the vesicle almost without angle, the latter with a horseshoe-shaped chitin-plate (Pl. III, fig. 8).

*Forficula* Linn.

The metaparameres are nearly or quite straight, and of equal breadth throughout their length, rounded at the tips. The virga is of various lengths, and enters the vesicle at various angles, both of which features seem to offer useful specific characters, as Zacher has suggested. The vesicle usually has a small chitin-lobe; possibly this is always present, as it is easily overlooked.

The virga is shorter than the metaparameres in *F. rodzianko* Sem. and *F. lucasi* Dohrn (fide Zacher), *F. auricularia* L. (Pl. III, fig. 13), *F. senegalensis* Serv. (Pl. III, fig. 15), and *F. lurida* Fisch. (Pl. III, fig. 11), and in all this group enters the vesicle almost without angle. In *F. auricularia* and *F. senegalensis* the metaparameres are rather convex externally. In the next group the virga is about one and a quarter to one and a half times as long as the metaparameres, and enters the vesicle at an obtuse angle; to this

group belong *F. mikado* Burr. (fide Zacher), *F. pubescens* Géné (Pl. III, fig. 12), and *F. lesnei* Finot (Pl. III, fig. 14).

The next group, according to Zacher, is illustrated so far only by *F. ruficollis* Fabr., where the virga is of medium length, as in the preceding group, but is elbowed in the form of a U at the junction with the vesicle. *F. ætolica* Br. (Pl. III, fig. 9), and *F. sjöstedhi* Burr (Pl. III, fig. 10), belong to this second group. In the former, the parameres typical; virga fairly long, and little more than three times as long as the reniform vesicle, which has a feeble chitinous reinforcement on the concave side.

The last group, according to Zacher, is that of *F. smyrnensis*, where the virga is more than three times as long as the meta-parameres, protruding far beyond them even when retracted, and strongly elbowed into a U at the junction with the vesicle.

In *F. beelzebub* the virga is long and sinuate; it is feebly angled at the entrance into the basal vesicle, which has chitinous reinforcement. The ejaculatory duct is long and coiled (Pl. IV, fig. 1).

### Subfamily Opisthocosmiinæ.

Zacher figures no species, but refers to *Eparchus insignis* Haan, *Opisthocosmia* (?) *longipes* Haan, *Cordax forcipatus* Haan, and *C. ceylonicus* Motsch., stating that the genitalia are of the same type as in *Forficula*.

I have a few species to add.

#### *Opisthocosmia* (?) *pœcilocera* Borg.

Metaparameres broad externally, decidedly convex, apically broadly rounded; virga about twice as long as the metaparameres, entering the simple vesicle without angle (Pl. IV, fig. 2).

#### *Cordax van kampeni* Burr.

Metaparameres short and broad, convex externally, rather narrowed towards the tips; virga about two and a half times as long as the metaparameres, strongly elbowed in the form of a U at the junction with the vesicle, which is small, simple, and scarcely inflated.

The three following species show a more complex type of vesicle, with long sinuous virga. In all three the metaparameres are rather broadened towards the apex, attaining their greatest breadth just before the tips, which are broadly rounded; the external margin is decidedly convex (Pl. IV, fig. 3).

### *Eparchus insignis* Haan.

Virga about two and a quarter times as long as the metaparameres; it is somewhat broadened at the base, and seems to enter the vesicle at its base, at a right angle. The latter is big, with a circular mouth on the upper end; it is protected by a narrow chitin-plate nearly twice as long as itself, armed with an elbowed lobe at the base. In the middle of the præputial sac there is a striated, ill-defined chitinous area (Pl. IV, fig. 4).

### *Thalperus kühlgatzi* Burr.

Virga nearly two and a half times as long as the metaparameres, apparently entering the vesicle without angle; the latter large, with a pair of lobes at the upper end, and protected, as in the preceding species, by a long, narrow, chitin-plate with an elbowed lobe at its base (Pl. IV, figs. 5 and 5*a*).

### *Narberia simplex* Borm.

Virga about two and half times as long as the metaparameres, terminating in a striated chitinous lobe at right angles; it is elbowed at the junction with the vesicle, which it enters at a right angle; the latter is big, with a striated chitinous structure at its upper end (Pl. IV, fig. 6).

### *Kosmetor burgursi* Burr.

A typically Forficuline armature; metaparameres ovate, outer margin convex and generally rounded; virga long, and quite simple; base not distinguishable (Pl. IV, fig. 7).

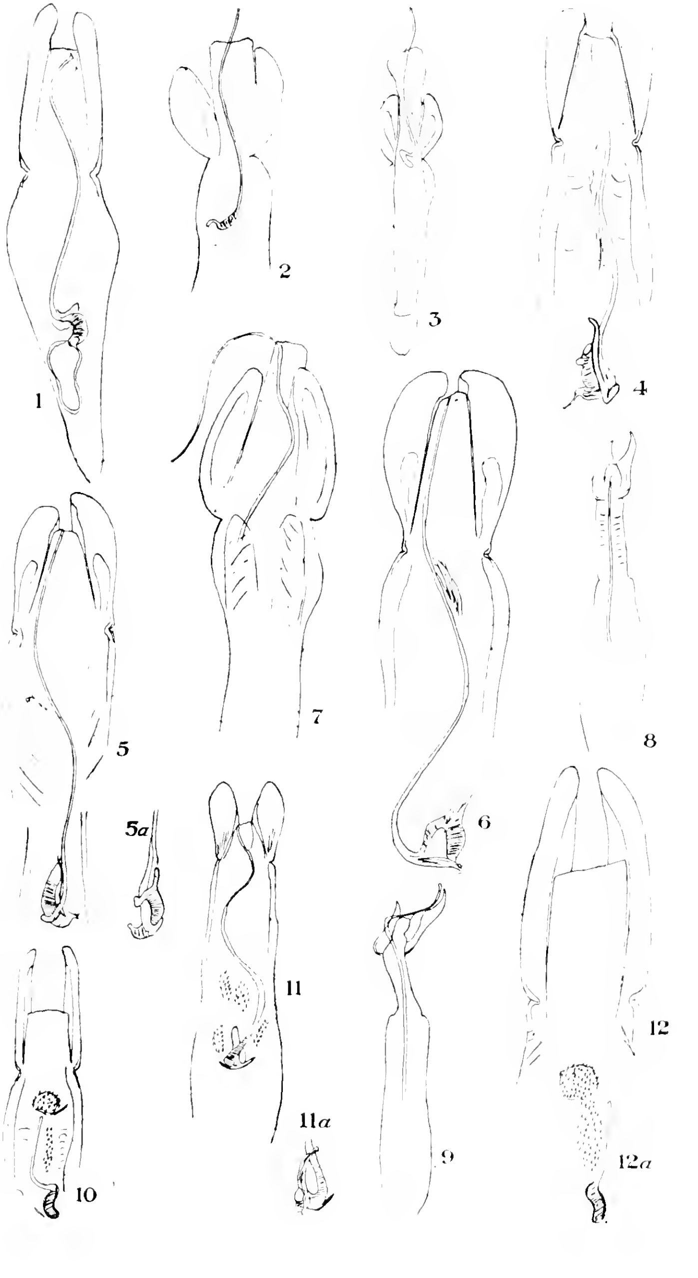
### *Kosmetor burgursi* sp. n.

Long and slender; shining black, the elytra and wings dull, and tarsi whitish; antennæ with seventeen segments, not very slender, cylindrical. Head tumid, sutures not distinct. Pronotum a little longer than broad, truncate anteriorly, rounded posteriorly. Elytra long, wings prominent; legs long and slender. Abdomen long and narrow, parallel-sided, the first six tergites in the male punctate, with granulated sides; sternites punctate at base of each

---

EXPLANATION OF PLATE IV.

FIG.
1. *Forficula beelzebub* Burr.
2. *Opisthocosmia* (?) *pœcilocera* Borg.
3. *Cordax van kampeni* Burr.
4. *Eparchas insignis* Haan.
5. *Thelperus kühlgatzi* Burr.
5*a*. Ditto.
6. *Narberie simplex* Borm.
7. *Kosmetor burgursi* Burr.
8. *Tristanella tuberculata* Bor.
9. Ditto.
10. *Diaperusticus sansibaricus* Karsch.
11. *Archidux adolfi* Burr.
12. *Diaperusticus erythrocephilus* Oliv.


1
2
3
4
5
5a
6
7
8
9
10
11
11a
12
12a

segment; last tergite square, smooth, tumid over the insertion of the forceps; process of pygidium in the male, short, broad, and blunt. Forceps with branches in the male remote at the base, very long and slender, with a small tooth near the base. In the female the abdomen is narrowed and forceps contiguous.

*Male.*—Length of body, 13·5–16 mm.; ditto forceps, 8–12·5 mm.

*Female.*—Length of body, 12·5–14·5 mm.; ditto forceps, 5·5–6 mm.

*Range.*—New Guinea: Hunsteinspitze, March 9, 1913, eight males, three females, one larva (Dr. Burgurs, Jr. No. 595, 1913, in Berlin Museum).

Distinguished by the long and slender build and uniform black colour.

## Subfamily ANCISTROGASTRINÆ.

Very little is yet known of the genitalia of this group. Zacher figures one, with a remarkable virga, under the name of *Sarakas aterrimus* Borm. I cannot understand what species he really refers to, as *Sarakas* is characterized by the non-carinate elytra, and *aterrimus* Borm. is the true name of *amazonensis* Borm., which is the type and only known species of *Kleter* Burr, a genus which has strongly carinate elytra. Zacher's figure is doubtless of a Neotropical species; the metaparameres are typically Forficuline, but the virga is peculiar, and the præputial sac has a denticulate area.

Zacher also refers briefly to *Tristanella* sp., stating that the virga "ist ganz gerade, stabförmig."

I offer *Tristanella tuberculata* Bor., in which we find a marked divergence from the Forficuline type. The virga is certainly quite straight, except when protruded, as seen in Pl. IV, figs. 8 and 9, of the specimen in erection. In repose it is at least three times as long as the metaparameres. Unfortunately, in both my specimens, the basal part of the virga and the vesicle are obscured by a mass of muscle and tissue which is rather heavily stained.

But it is in the form of the metaparameres that we find the most striking feature. In both my specimens these are of unequal length, asymmetrically bent, both in the same direction and not reciprocally. They are relatively long, bisinuate, narrow, and apically acute; in fact, they recall the Labiine rather than the Forficuline type. I have examined the tarsi under the microscope. The first and second segments are of equal length; the second is about twice as long as broad, and is rounded—viewed laterally, it is a decidedly Forficuline tarsus; the basal segment is clad with long hairs, but has no stiff spiniform bristles, neither along its sides, nor at the apex; the posterior tibiæ have a dense series of stiff spiniform bristles towards and at the apex. The tarsi agree

exactly with those of *Ancistrogaster biolleyi* Bor. It will be very interesting to examine a good series of Ancistrogastrine genitalia, and to see whether *Tristanella tuberculata* is an exceptional or a typical form.

It is worth noting that the proparameres are very narrow, narrower than the metaparameres, which project at the hinge.

### Subfamily NEOLOBOPHORINÆ.

It will be interesting to see whether the genitalia of the flightless Neotropical genus *Neolobophora* agree at all with those of the flightless Ethiopian *Archidux*, which so closely resembles it in external features. *Archidux adolfi* Burr may possibly require separation from *Neolobophora*.

The metaparameres are rather short, about twice as long as broad, narrow at the base, widening to a maximum before the apex, and then reduced, by symmetrical narrowing on each side, to a blunt point. This is a different form from that seen in the *Forficulinæ* and *Opisthocosmiinæ*, where the metaparameres are rarely or never symmetrical about a median axis (Pl. IV, fig. 11).

The virga is sinuate, about three times as long as the metaparameres, entering the vesicle without angle. The latter is feebly dilated and furnished with a narrow chitinous plate on its upper end, where there is a large circular mouth, the horn apparently being the handle of a chitin-plate in the form of a double-headed pick, with the points at the base of the vesicle.

In the præputial sac there is a large denticulate area.

### Subfamily DIAPERASTICINÆ.

This group, undoubtedly allied to the *Forficulinæ*, is well characterized by the peculiar sexually dimorphic structure of the head capsule described by Zacher (D. Ent. Zeit. 1911, p. 145). The genitalia chiefly differ in having the præputial sac strongly denticulate. The parameres resemble those of *Forficula* and the allied genera, but are remarkable for their narrowness. The virga enters the vesicle at a very obtuse angle in *D. erythrocephalus* Oliv. (Pl. IV, fig. 12), but almost at a right angle in *D. sansibaricus* Karsch (Pl. IV, fig. 10). These are probably the only two good species of the group, as in my opinion *D. mackinderi* Burr is but a variant of the latter, and *D. cagnii* Bor., and *D. bonchampsi* Burr, are variants of the former species.

---

NOTE.—As Captain Burr is with H.M. Forces somewhere in the East, and has been unable to correct the revise of this part of his paper, it has been submitted to Mr. Hopkinson, for whose careful attention to it the thanks of the Society are due.

# II.—*Fifth List of New Rotifers since* 1889.

(*Period* 1912–1915.)

By Charles F. Rousselet, F.R.M.S.

(*Read December* 15, 1915.)

In the four previous Lists of New Rotifers since 1889 published in this Journal* since 1893, I have recorded a total of 607 names. The present Fifth List contains 132 additional species described since 1912, making a total of 739 since 1889, the date of issue of the Supplement to Hudson and Gosse's great Monograph.

In 1889 Dr. Hudson estimated the number of recognizable species at about 400.

In 1912, after making allowance for the numerous synonyms and duplication of names, my estimation of the Rotiferous population of the world was 850; at the end of 1915, after a similar allowance, my estimate must be increased to approximately 960 species.

With a few exceptions authors have of late years paid more attention to adequate descriptions and correct figures of new species, but there is still room for taking seriously to heart James Murray's advice in one of his latest papers (249)† where he says: "The conscientious systematist, if he wishes his work to have any value, has no alternative but to figure most of the species observed; you know then what he means by his names, and if he makes a mis-identification, no harm is done"; and again (253): "If a man can neither observe carefully, nor describe faithfully, nor draw accurately, surely he might leave the poor beasts alone." Few persons, I take it, will be found to disagree with these recommendations.

James Murray has unfortunately not returned from his last journey with the Canadian Arctic Expedition under Stefansson. The 'Karluk,' on which he served as Oceanographer and Biologist of the Expedition, was crushed in the ice and sank near Herald Island, and though a few succeeded in making their escape to

* For the four previous Lists, see this Journal, 1893, pp. 450–458; 1897, pp. 10–15; 1902, pp. 148–154; 1912, pp. 151–165.

† The numbers in brackets refer to the Bibliography at the end of the paper.

Wrangel Island, Murray was among those who did not reach land. His last five papers on Rotifera, published in this Journal in 1913, were written at a time when he was actively preparing for this Expedition, and the proof sheets were actually sent to him and corrected while on his way to Alaska, and were returned from Nome shortly before the 'Karluk' sailed on its last and fateful voyage.

In 1913 Mr. H. K. Harring, of Washington, published a Synopsis of the Rotifera (232), which contains a very elaborate and exact bibliographical record of all the world's published papers on this class. The classification proposed is based on a rigorous application of the International Code of Zoological Nomenclature adopted by the various international congresses of Zoology. The result is that twenty-nine generally accepted generic names were replaced by unfamiliar names. The following is a list of the genera thus replaced :—

| Present Generic Names to be discarded. | New Generic Names substituted. |
|---|---|
| *Apsilus* | *Cupelopagis* (Forbes) |
| *Anuræa* | *Keratella* (Bory de St. Vincent) |
| *Cephalosiphon* | *Beauchampia* (Harring) g. n. |
| *Cathypna* | *Lecane* (Nitzsch) |
| *Callidina* | *Macrotrachela* (Milne) |
| *Diglena* | *Cephalodella* (Ehrenberg) |
| *Diplax* | *Mytilina* (Bory) |
| *Distyla* | *Lecane* (Nitzsch) |
| *Distemma* | *Dicranophorus* (Nitzsch) |
| *Dinocharis* | *Trichotria* (Bory) |
| *Floscularia* | *Collotheca* (Harring) g. n. |
| *Furcularia* | *Encentrum* (Ehrenberg) |
| *Hydatina* | *Epiphanes* (Ehrenberg) |
| *Metopidia* | *Lepadella* (Bory) |
| *Melicerta* | *Floscularia* (Cuvier) |
| *Microdina* | *Philodinavus* (Harring) g. n. |
| *Megalotrocha* | *Sinantherina* (Bory) |
| *Notops* | *Epiphanes* (Ehrenberg) |
| *Noteus* | *Platyias* (Harring) g. n. |
| *Œcistes* | *Ptygura* (Ehrenberg) |
| *Polychætus* | *Macrochætus* (Perty) |
| *Pterodina* | *Testudinella* (Bory) |
| *Pedalion* | *Pedalia* (Barrois) |
| *Rattulus* | *Trichocerca* (Lamarck) |
| *Rhinops* | *Rhinoglena* (Ehrenberg) |
| *Rotifer* | *Rotaria* (Scopoli) |
| *Stephonops* | *Squatinella* (Bory) |
| *Triarthra* | *Filinia* (Bory) |
| *Salpina* | *Mytilina* (Bory) |

These changes of names, and in particular the inversion of names, such as *Floscularia* for the ancient and familiar *Melicerta*, have been contested, by de Beauchamp (229) for instance, who is himself an advocate of a strict maintenance of the code of rules created by the International Zoological Congresses. To this Harring has published a reply (232A), contending that de Beauchamp's interpretation of the code is incorrect, and that he has not established any contradictions.

Whether this new classification will be finally accepted may depend upon the action of the Commission of Zoological Nomenclature of future International Congresses; meanwhile it is admitted that the synopsis has not the force of law, though the author confidently claims that it is in agreement with the international code. Some authors will no doubt accept the new names, whilst others may reject them, and some have already printed both the names, which does not look like a simplification of zoological nomenclature.

As long as the classification is in agreement with the international code, zoologists will have no choice in the matter but to accept it, however reluctant, and against their grain the new names may be, unless indeed some specialist, with an intimate knowledge of the more obscure groups of Rotifera, can succeed in showing some errors or contradictions, when that part of the elaborate work will have to be recast or done over again. Harring has shown unbounded courage in undertaking single-handed such a stupendous work, when it might have been accomplished by a dozen specialists well versed in the various groups of Rotifera, with powers, like those vested in the International Commission of Nomenclature, of recommending their conclusions for adoption by the International Congress of Zoology.

It seems a pity that, as regards microscopic animals, a later date than Linné's "Systema Naturæ," 10th Edition, 1758, when it was obviously impossible for authors to have even an approximately correct knowledge of the animals they were describing and naming, should not have been fixed. On the other hand, it is difficult to indicate what other date could have been selected as a starting-point.

The author of this new Nonemclature is well aware that it will cause much temporary inconvenience, but he considers that it offers the only means of escape from the present chaotic condition.

The object of this list, however, is only to record the names of new species and not to criticize them, unless they are synonyms. For greater lucidity I have here added the old generic names, in parenthesis, to the new and unfamiliar names of Harring's new classification.

### Rhizota.

*Floscularia ferox* Pénard (254).
,, *paradoxa* Pénard (254).
,, *monoceros* Zacharias (261).
*Collotheca* (*Floscularia*) *polyphema* Harring (234).
*Hyalocephalus trilobus* Lucks (241, 243).
*Œcistes cristatus* Murray (252).
,, *pectinifer* Murray (249).

### Bdelloida.

*Rotifer quadrangularis* Heinis (235).
,, *tridens* Montet (246).
*Philodina americana* Murray (249).
*Callidina Bilfingeri* Bryce (227).
*Habrotrocha cuneata* Murray (250).
,, *flava* Bryce (228).
,, *Fuhrmanni* Heinis (235).
,, *gracilis* Montet (246).
,, *insignis* Bryce (228).
,, *ligula* Bryce (227).
,, *longula* Bryce (228).
,, *munda* Bryce (227).
,, *pavida* Bryce (228).
,, *spicula* Bryce (227).
,, *sylvestris* Bryce (228).
,, *torquata* Bryce (227).
*Pleuretra triangularis* Murray (248).

### Ploïma. I. Il-loricata.

*Asplanchna priodonta* var. *minor* Voronkow (257).
*Asplanchnopus hyalinus* Harring (233).
*Encentrum* (*Pleurotrocha*) aper. Harring (233).
,, *myriophylli* Harring (233).
,, *ricciæ* Harring (233).
*Pleurotrocha minima* Montet (246).
*Diglena difflugiarum* Pénard (254).
,, *Hofsteni* de Beauchamp (229).
,, *Coëzi* de Beauchamp (229).
,, *tenuidens* de Beauchamp (229).
*Triarthra terminalis* var. *maior* Colditz (230).
*Rousseletia corniculata* Harring (233).

PLOÏMA. II. Loricata.

*Diurella brevistyla* Lucks (242).
„ *bidens* Lucks (242) (= *D. cavia* Gosse).
„ *voluta* Murray (249).
*Coelopus* (*Diurella*) *bambekei* Mola (245).
*Rattulus braziliensis* Murray (249).
„ *flavus* Voronkow (257).
„ *orca* Murray (252).
*Mastigocerca* (*Rattulus*) *bicurvicornis* Mola (245).
„ ( „ ) *elegans* Meissner (244) (= *Rattulus cylindricus* Imhof).
„ ( „ ) *pusilla* Lauterborn (238).
„ ( „ ) *wolgensis* Meissner (244) (= *Diurella stylata* Eyferth).
*Trichocerca* (*Rattulus*) *nitida* Harring (234).
*Dinocharis curta* Scorikow (256) (= *Trichotrichia* (sic) *curta* Voronkow (260) ).
„ *tetractis* forma *caudata* Lucks (242).
„ *pocillum* var. *bergi* Meissner (244A).
*Trichotria* (*Dinocharis*) *brevidactyla* Harring (233) (= *Dinocharis curta* Scorikow (256) ).
*Euchlanis alata* Voronkow (259).
*Diplois phlegræa* Iroso (236) (236A).
*Diplax videns* var. *longipes* Voronkow (257) ( = *Euchlanis bicarinata* Perty).
„ *bisulcata* Lucks (242).
„ *crassipes* Lucks (242).
„ *unguipes* Lucks (242).
*Monostyla acus* Harring (233).
„ *amazonica* Murray (250).
„ *asymmetrica* Murray (250).
„ *batillifer* Murray (252)
„ *cochlearis* Murray (250).
„ *constricta* Murray (253).
„ *crenata* Harring (233).
„ *decipiens* Murray (250).
„ *dentiserratus* Mola (245).
„ *diophthalma* Iroso (236) (236A) (? = *M. robusta* Stokes).
„ *falcata* Murray (253).
„ *furcata* Murray (250).
„ *obtusa* Murray (250).
„ *punctata* Murray (250).
„ *rugosa* Harring (234).
„ *sylvatica* Harring (233).

*Monostyla stenroosi* Meissner (244A).
,, *testudinea* Mola (245) (245A).
,, *turbo* Murray (253).
,, *ungulata* Mola (245) (245A).
,, *virga* Harring (234).
*Distyla acinaces* Mola (245) (245A).
,, *aculeata* Jakubski (237).
,, *carinata* Jakubski (237).
,, *korschelti* Mola (245) (245A).
,, *terracciunoi* Mola (245) (245A).
,, *truncata* Leissling (240) (= *D. brachydactyla* Stenroos) (123).
*Cathypna brevis* Murray (253).
,, *curvicornis* Murray (250).
,, *grandis* Murray (250).
,, *hastata* Murray (250).
,, *lufuana* Murray (253).
,, *mira* Murray (253).
,, *nana* Murray (250).
,, *nitida* Murray (250).
,, *papuana* Murray (253).
,, *Weberi* Mola (245) (245A).
*Lecane* (*Cathypna*) *æquanea* Harring (234).
,, ( ,, ) *amorpha* Harring (234).
,, ( ,, ) *arcula* Harring (234).
,, ( ,, ) *compta* Harring (234).
,, ( ,, ) *crepida* Harring (234).
,, ( ,, ) *doryssa* Harring (234).
,, ( ,, ) *elegans* Harring (234).
,, ( ,, ) *ercodes* Harring (234).
,, ( ,, ) *Marshi* Harring (234).
,, ( ,, ) *pusilla* Harring (234).
,, ( ,, ) *sibina* Harring (234).
,, ( ,, ) *stichæa* Harring (233).
,, ( ,, ) *tenuiseta* Harring (234).
*Colurus compressus* Lucks. (242).
,, *longidigitus* Mola (245) (245A).
*Oxysterna maior* Iroso (236) (236A) (= *Metopidia oxysternum* Gosse).
*Metopidia similis* Lucks (242).
,, *quinquecostata* Lucks (242).
,, *Rottenburgi* Lucks (242) (? = *M. dactyliseta* Stenroos (123)).
,, *heterostyla* Murray (252).
,, *scutumpes* Mola (245) (245A).
*Lepadella* (*Metopidia*) *dactyliseta* var. *bidentata* Voronkow (260).
,, ( ,, ) *imbricata* Harring (234).

*Lepadella* (*Metopidia*) *cyrtopus* Harring (234).
*Pterodina striata* Murray (252).
*Brachionus quadricornis* Meissner (244) ( ? = *B. budapestinensis* Daday).
,, *Bakeri* var. *Zernowi* Voronkow (258).
,, *falcatus* var. *lyratus* Lemmermann (239).
,, *macrocanthus* Jakubski (237).
,, *furculatus* var. *testudinarius* Jakubski (237) (= *B. bidentatus* Anderson).
,, *pterodinoïdes* Rousselet (255).
,, *trahea* Murray (251).
,, *similis* Leissling (240) (= *B. budapestinensis* Daday).
,, *angularis* var. *ecornis* Voronkow (260).
,, *forficula* var. *minor* Voronkow (260) (= *B. haranaensis* Rousselet) (211).
,, *dolobratus* Harring (234).
,, *variabilis* var. *novæ-zealandiæ* Morris (247) (parasitic on *Daphnia thompsoni*).
*Anuræa clypeus* Daday (231).
,, *angulata* Daday (231).

## *New Genera.*

*Rousseletia* (*R. cornicula*) Harring (233).
*Sphyrias* (*S. lofuana* for *Notops lofuana* Rousselet (210) ) Harring (233).
*Beauchampia* (*B. crucigera* = *Cephalosiphon limnias*) Harring (232) (233).
*Parasynchæta* Lauterborn (238A) (*P. monopus* Plate).
*Wolga* (*W. spinifera*) Voronkow (257) (for *Distyla spinifera* Western).
*Collotheca* Harring (232) (for *Floscularia* Cuvier).
*Philodinavus* Harring (232) (for *Microdina* Murray).
*Platyias* Harring (232) (for *Noteus* Ehrenberg).
*Pedalia* Barrois (for *Pedalion Hudson* Harring (232) Rousselet (255A).
*Oxysterna* Iroso (236) (for *Metopidia oxysternum* Gosse).

## *New Specific Name for old Species.*

*Anuræa paludosa* Lucks (242) (for *A. aculeata* var. *cochlearis* Voigt) (225).

## Bibliography.

*(Continued from Fourth List.)*

N.B—The works here enumerated contain the description of the new Rotifers in preceding list, but they are not, and do not pretend to be, a complete list of papers on Rotifers in general which have appeared during the period covered by the list.


227. Bryce, David.—On five new species of Bdelloid Rotifera. Journ. Quekett Micr. Club, ser. 2, xii. No. 72, 1913, pp. 83–84 (2 pl.).

228. —— On five new species of the genus *Habrotrocha.* Journ. Quekett Micr. Club, ser. 2, xii. No. 77, 1915, pp. 631–42 (2 pls.).

229. Beauchamp, P. de—Documents sur les Notommatidés à mastax forcipé, avec quelques remarques sur la nomenclature des Rotifères. Soc. Zool. de France. xxxviii. (1913) pp. 291–335 (9 figs.)

230. Colditz, Fried. V.—Beiträge zur Biologie des Mansfelder Sees. Zeitschr. f. wiss. Zool., cviii. (1914) pp. 520–630.

231. Daday, E. von.—Mikrofauna des Kossogol-Beckens in der Nordwestlichen Mongolei. Mathem. Naturw. Berichte aus Ungarn. xxvi. (1908) pp. 274–360. (Sonderabdruck, 1913.)

232. Harring, Harry K.—Synopsis of the Rotatoria. Washington, 1913.

232a.—— Notes on Rotatorian Nomenclature. Zool. Anzeig., xliv. 11 (1914) pp. 500–2.

233. —— A List of the Rotatoria of Washington and Vicinity, with description of a new genus and ten new species. Proc. U.S. Nat. Museum, lxvi. (1913) pp. 387–405 (5 pl.)

234. —— Report on Rotatoria from Panama, with description of new species. Proc. U.S. Nat. Museum, xlvii. (1914) pp. 525–64 (9 pls.).

235. Heinis, Fr. — Die Moosfauna Columbiens. Mem. de la Soc. neuchâteloise d. Sciences naturelles, v. (1913) pp. 698–713 (24 figs.).

236. Iroso, Isabella—Primo contributio alla conoscenza dei Rotiferi del lago-stagno craterico di Astroni. Mon. Zool. Ital., xxi. (1910) pp. 299–304.

236a.—— I Rotiferi del lago-stagno craterico di Astroni. Atti d. R. Inst. d'Incoragg. di Napoli, 1912 (1913) pp. 445–93 (1 Tav.).

237. Jakubski, A. W.—Beiträge zur Kenntnis der Süsswassermicrofauna Ostafrikas. Zool. Anzeig, xxxix. (1912) pp. 536–50.

238. Lauterborn, Robert—Ueber die zyklische Fortpflanzung limnetischer Rotatorien. Biol. Centralbl., xviii. (1898) pp. 173–83.

238a.—— Nordische Plankton Rotatorien. Nordisches Plankton, Kiel, 1905.

239. LEMMERMANN, E.—Beiträge zur Kenntnis der Planktonalgen. Archiv f. Hydrobiologie, iii. (1908) pp. 329–410.

240. LEISSLING, RICHARD—Ein Beitrag zur Rotatorienfauna der Plöner Gewässer. Archiv f. Hydrobiologie u. Planktonkunde, ix. (1913–14) pp. 253–8 (3 figs.).

241. LUCKS, R.—Ueber ein neues Rädertier. Zool. Anzeig, xxxviii. (1911) pp. 568–71.

242. —— Zur Rotatorienfauna Westpreussens. Danzig, 1912, 207 pp. (106 figs.).

243. —— Zur Organisation von *Hyalocephalus trilobus* g. et sp. n. Zool. Jahrb., xxxiv. (1913) pp. 321–40.

244. MEISSNER, V.—Animal Plankton in the Volga at Saratow. Compte Rendus des Travaux des Vacances (1901) de la Station Biol. du Volga (Saratow, 1902). (Russian text.)

244A.—— Mikroskopische Wassertiere des Aralsees und der einmündenden Flüsse. Mitt. k. Russ. Geogr. Ges. Turkestan Abt., iv. 8 (St. Petersburg, 1908) pp. 1–102 (mit 4 Taf. 1–4).

245. MOLA, PASQUALE—Nuove specie di Rotiferi loricati. Zool. Anzeig., xlii. (1913) pp. 112–25 (figs.).

245A.—— Fauna Rotatoria Sarda: Contributo alla idrobiologia della Sardegna. Annales de Biologie lacustre, vi. (1913) pp. 1–88.

246. MONTET, G.—Contribution à l'étude des Rotateurs du Bassin du Léman (Région du Haut-Lac). Revue Suisse de Zool., xxiii. No. 7 (1915) pp. 251–360 (7 pls.).

247. MORRIS, C. BARHAM—Some Notes on Rotifera not previously recorded as occurring in New Zealand. Trans. New Zealand Institute, xlv. (1913) pp. 163–7 (1 fig.).

248. MURRAY, JAMES—Notes on the Nat. Hist. of Bolivia and Peru. Scottish Oceanographical Laboratory, Edinburgh, 1913.

249. —— South American Rotifera. Journ. Roy. Micr. Soc., 1913, pp. 229–46 (2 pls.).

250. —— South American Rotifera. Part II. Journ. Roy. Micr. Soc., 1913, pp. 341–62 (3 pls.).

251. —— South American Rotifera. Part III. Journ. Roy. Micr. Soc., 1913, pp. 449–54 (1 pl.).

252. —— Australasian Rotifera. Journ. Roy. Micr. Soc., 1913, pp. 455–61 (1 pl.).

253. —— Notes on the Family Cathypnidæ. Journ. Roy. Micr. Soc., 1913. pp. 545–64 (2 pls.).

254. PÉNARD, E.—A propos de Rotifères. Revue Suisse de Zool. Genève, xxii. (1914) pp. 1–25 (1 pl.).

255. ROUSSELET, CHARLES F.—The Rotifera of Devils Lake, with description of a new *Brachionus*. Journ. Quekett Micr. Club, ser. 2, xii. (1913) pp. 57–64 (2 pls.).

255A.—— *Pedalion* ou *Pedalia* : une question de nomenclature dans la classe des Rotifères. Journ. Quekett Micr. Club, Ser. 2, xii. (1914) pp. 397–8. C. R. des Séances du Congrès de l'Assoc. Française pour l'Avancement des Sciences au Hâvre. Séance du 1 Août, 1914. Paris, 1915, pp. 535–6.

256. SCORIKOW, A. S.—Verzeichnis der Organismen welche im Arbeitsfelde der Biol. Wolga-Station in Saratow, gefunden wurden und bis jetzt bestimmt worden sind, 1900–2. Jahrb. Biol. Volga Station. Saratow, 1913. (Russian text.)

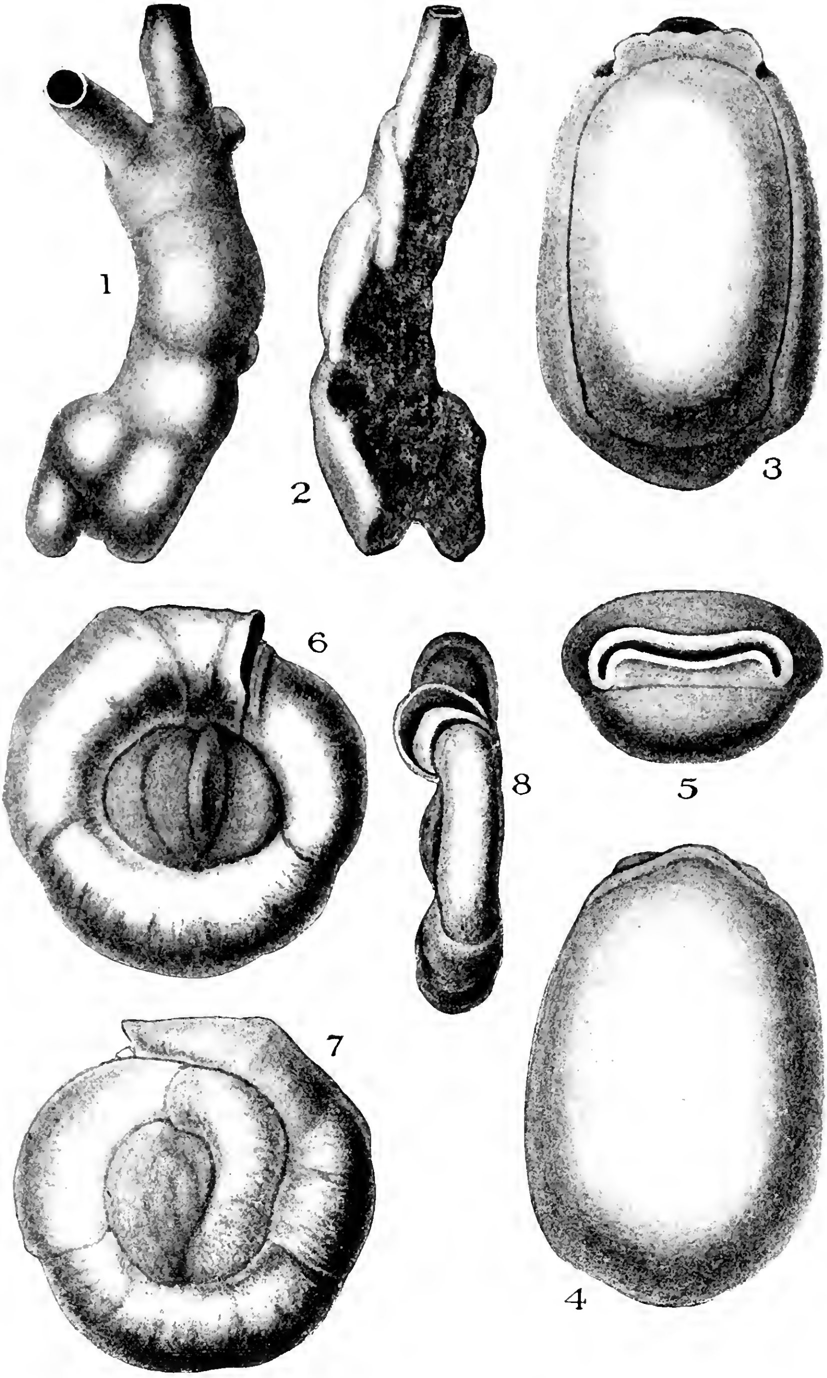
257. VORONKOW, N.—Rotatoria of the Gouvernement Moskva. Moscow, 1907 (2 pls.). (Russian text.)

258. —— The Rotatorian Fauna of the Gouvernement Minsk. Moscow, 1909. (Russian text.)

259. —— Sur le Plankton des Bassins de la Presqu'île de Yamal. Ann. Mus. Zool. Acad. de Sciences St. Petersbourg, xvi. (1911) pp. 180–214 (4 pls.). (Russian text.)

260. —— Zur Rotatorien fauna Russlands. Arbeiten der Station am Glubokoje-See, v. Heft 1, 1913 (9 figs). (Russian text.)

261. ZACHARIAS, OTTO.—Ein neues Rädertier : *Floscularia monocercus*. Archiv f. Hydrobiol u. Pflanzenkunde, viii. (1912–13) pp. 139–41 (1 fig.).




Foraminifera of South Cornwall.

# III.—*The Foraminifera of the Shore-sands, and Shallow Water Zone of the South Coast of Cornwall.*

By Edward Heron-Allen, F.L.S. F.G.S. F.Z.S. F.R.M.S., and Arthur Earland, F.R.M.S.

(*Read November* 17, 1915.)

Plates V. to IX.

The examination of material from one highly prolific dredging off the south coast of Cornwall, and littoral gatherings from ten localities between the Land's End and Plymouth, has proved to be a task of remarkable interest owing to the richness of the marine protozoan fauna, both as regards its abundance and development, and the result of our examinations has been a list of 221 species and varieties for the area under consideration. This list is expanded to 256 by the addition of thirty-five species recorded in the papers of Millett, Worth and Robertson, to which reference is made below, and which we have added in order that this present paper may be regarded as complete up to the time of writing.

The major portion of the ground may be said to have been practically untouched hitherto. The late F. W. Millett published in 1885* a list of 108 species and varieties, but his paper, as the Introduction shows, was in the nature of a popular article, and no authors of species, frequencies or diagnostic observations were

* F. W. Millett, "The Recent Foraminifera of Mount's Bay." Trans. Penzance Nat. Hist. and Antiq. Soc., 1884–5, 3 pp.

---

EXPLANATION OF PLATE V.

FIGS.

1–2.—*Nubecularia lucifuga* Defrance. Abnormal form with tubular extensions. Fig. 1, upper surface. Fig. 2, under surface (originally attached). × 65.

3–5.—*Biloculina elongata* d'Orbigny. Figs. 3, 4, side views. Fig. 5, oral view. × 65.

6–8.—*Miliolina subrotunda* (Montagu). Abnormal hauerine form. Figs. 6, 7, side views. Fig. 8, edge (oral) view. × 85.

The drawings for the Plates illustrating this paper were made from the specimens by Mr. John R. Ford.

given.* R. H. Worth has contributed a more scientific list of 116 species to a publication of the Plymouth Marine Biological Association,† but this is a list which may be taken to represent only the extreme eastern section of our area. The list is, however, a very valuable one, as it complements the records from our Station I, being principally derived from dredgings made in, and to the south and west of, Plymouth Sound, and around the Eddystone Lighthouse, and may therefore be regarded as primarily dealing with Cornish Foraminifera.

Finally, we may mention a list of thirty-five species published by the late David Robertson (without frequencies) in 1869 in the Report of the British Association for that year.‡ All the species recorded occur in our list with the single exception of *Nonionina turgida* Williamson. The only indication of locality is contained in a phrase in the introductory paragraph, "taken in about 40 fms. 7 miles south-east of the Eddystone, and some 14 miles south-east of the Dudman in about the same depth of water." This paper may therefore also be taken to be primarily concerned with our area.§

Lists of Foraminifera from the adjacent shores of Devonshire may be found in E. Parfitt's paper "On the Protozoa of Devonshire," ‖ in which seventy-one species are recorded from Exmouth, Plymouth Sound, Eddystone, Brixham, Salcombe Bay, and Torbay; and R. H. Worth has contributed a list of thirty species to E. J. Allen and R. A. Todd's paper, "The Fauna of the Salcombe Estuary."¶

The shore-gatherings forming the subject of the present paper have been made, as will be seen by the List of Stations, over a period of more than twenty years, and have been supplemented by

* Among the Millett MSS. which have come into our possession is a "List of Recent Foraminifera of Marazion, Mounts Bay, supplied to Prof. Jas. Clark, 4th March 1906." This is primarily founded upon the 1884–5 paper, but a few species are added, including *Placopsilina varians* (Carter), [see No. 46 *Iridia diaphana* Heron-Allen and Earland and note thereon], and *Lagena faba* Balkwill and Millett. This latter species does not appear in our list, nor in those to which we have otherwise referred. We have indicated the species thus added to Millett's 1884–5 list by the sign (M. 1906).

† R. H. Worth, in "Plymouth Marine Invertebrate Fauna," Journ. Mar. Biol. Assoc., vol. vii. 1904, pp. 174–85.

‡ "Report of the Committee appointed to explore the Marine Fauna and Flora of the South Coast of Devon and Cornwall." Rep. Brit. Ass. (Exeter, 1869), London, 1870, p. 91. "Foraminifera," by David Robertson.

§ In Jones and Parker's paper "On some Recent and Fossil Foraminifera Dredgings in the English Channel" (Ann. and Mag. Nat. Hist. Ser. 4, vol. xvii. 1876, pp. 252–7), a list is given of thirty-two species from a dredging made by Dr. S. P. Woodward and Mr. McAndrew in 60 fms. 40 miles south of the Scilly Islands. This is hardly related to our area, but all the species named occur under one name or another, in our list, with the exception of *Polymorphina horrida* Reuss, *P. costata* Egger. and *Nodosaria raphanus* (Linné).

‖ Trans. Devon. Assoc. Adv. Science, Lit. and Art, 1869, p. 16.

¶ Journ. Mar. Biol. Assoc. (Plymouth), vol. vi. (1900), p. 182.

a certain number of specimens found upon dilapidated type-slides from the Millett Collection (which now forms part of our own), and by a tube of floatings from the same source, made from shore-sand collected at Fowey. The material may therefore be said to be virtually complete and representative, and it presents one or two points which are worthy of note.

With the exception of our recently recorded genus and species *Iridia diaphana* * no Astrorhizidæ were found. The family is normally rare in shore-gatherings, and the material examined contained but few Molluscan or other fragments upon which the adherent forms might have been found, but the otherwise extremely rich dredging off Newlyn (Station I) was noteworthy for a like absence of these Arenacea.

The material from the area in general was, as might have been expected from the geological features of the neighbouring shores, more free from derived fossils than is usually the case in British shore-gatherings; but at Station III (Marazion) chalk fossils were found of the species *Anomalina ammonoides* (Reuss) and *Textularia globulosa* Ehrenberg, and at Station VII (Veryan Bay) Eocene fossils of the species *Bulimina elongata* d'Orbigny, and *Discorbina bertheloti* d'Orbigny. How these specimens arrived in these localities, whether washed by tides from as far east as the Isle of Wight or derived from a submarine outcrop, it is impossible to conjecture, though the Chalk fossils may have been derived from Beer Head, South Devon. The same problem arises in connexion with a single fine and typical example of *Faujasina carinata* d'Orbigny, a common fossil in the Pliocene of St. Erth, Cornwall, which occurred in the shore-sand at Station II (Penzance), and which we figure (Pl. IX, figs. 6–8). How this specimen from an inland and purely local deposit can have found its way to the shore-sand of Penzance is entirely obscure.

At Marazion several specimens of the fresh-water Rhizopod *Difflugia pyriformis* Perty were found, which we have dealt with, sub *Reophax difflugiformis.*

Three forms are recorded as new to Britain, *Cristellaria hauerina* d'Orbigny, *Polymorphina complexa* Sidebottom, and *Discorbina bertheloti* var. *baconica* Hantken; and recorded for the second time as British are *Haplophragmium runianum* H-A. & E., *Discorbina chasteri* var. *bispinosa* H-A. & E., and *Pulvinulina patagonica* var. *scitula* Brady.

Excepting in the case of the latter species, we have not given the usual synonymies or references in this paper, but we have given in every case a reference to easily accessible papers in which the synonymies and references are either historically important, or fairly full and brought up to date, and with a view to concentrat-

* H-A. & E., 1914, F.K.A., pp. 371. et seq.

ing them we have as far as possible referred either to Brady's 'Challenger' Report, in which all important historical references are given down to the year 1884, or to our Kerimba Monograph (Part II., 1915), in which the most useful references since 1884 are given in some fullness.

The material from Station III presents a certain specialized interest from the fact that it was derived from (*a*) the shore-sand and (*b*) the apertural fringes of tubes of the marine worm *Terebella conchilega*; and though the material (*a*) was practically unlimited, whilst the material (*b*) consisted of the fringes of only twelve tubes, (*a*) yielded sixty-nine species, of which no less than sixty-three were found in (*b*). The only suggestion we can make to account for the profusion of Foraminifera on the fringes is that the fringes are extruded above the sand in a more or less viscous condition, and that the gentle rising of the tide in calm weather floats up against them the Foraminifera lying on the surface of the sand before the heavier sands themselves are disturbed. It is a noteworthy fact that the portions of the tubes themselves lying below the surface of the sand are practically devoid of Foraminiferal shells.*

---

## List of Stations and Material Examined.

I. Mounts Bay. Dredging 35 to 40 fms. 4 to 5 miles off Newlyn. June 14, 1914. Bulk of material, unlimited.

II. Penzance. Shore-sand. A series of scrapings made in May 1904. Bulk of material, unlimited.

III. Marazion.

(*a*) Shore-sand. Scrapings made May 1904. Bulk, 1 quart.

(*b*) ,, ,, The fringes of twelve tubes of *Terebella conchilega.* (May 1904.)

(*c*) ,, ,, Several damaged type-slides from the Millett Collection.

IV. Mullyon. Shore-sand. Collected August 1892. Bulk, unlimited.

* Cf. a paper on this subject by Prof. Hennessy, F.R.S., in Proc. Roy. Irish Acad. Sci., i. (1871) p. 153, "On the Flotation of Sand by the Rising Tide in a Tidal Estuary." He points out that "the particles of sand, shell, etc., which had become perfectly dry and sensibly warm under the rays of the sun, were gently uplifted by the calm, steadily rising water, and then floated as easily as chips or straws." (See on this subject also A. T. Watson, on "The Tube-building Habits of *Terebella littoralis*," Journ. R. Micr. Soc., 1890, p. 635, pl. xix.)

V. St. Mawes, Falmouth.

(*a*) Shore-sand from a landing cove immediately to the east of "The Haven." Bulk, 2 quarts.

(*b*) Washings from green algæ and rock scrapings from the rocks under St. Mawes Castle (West). Bulk, 1 quart. Collected August 1913.

VI. Falmouth. Kilgerran Bay, E. of Greeb Point. Shore-sand and washings from green algæ. Bulk, 1 quart. Collected August 1913.

VII. Veryan Bay. Pendower Sands. Shore-sand. Bulk, 1 quart. Collected August 1910 and August 1913.

VIII. Fowey.

(*a*) Par Sands. Shore-sand and washings from green algæ. Bulk, 1 quart. Collected August 1913.

(*b*) A small tube of floatings. Date unknown. Bulk, 1 cc. From the Millett Collection.

IX. Plymouth (S.-W.). Whitsand Bay. Shore-sand. Bulk, 400 cc. Collected by Dr. J. H. Orton (Marine Biol. Lab., Plymouth, Oct. 1914). (Floated Foraminifera, 3 cc.)

X. Mevagissey. Shore-sand. Bulk, 130 cc. (Floated Foraminifera, 1 cc.) Collected in January 1913 by Mr. Howard Dunn. The occurrence of species at this station is indicated by the figure X, but the frequencies are not added, the sample being of insufficient bulk to give reliable indications.

---

In the following list c. = common, f. = frequent, r. = rare, v.r. = very rare.

(M.) signifies that the species was recorded by Millett in his 1884–5 paper.

(P.) signifies that the species is recorded by Worth in the "Plymouth Invertebrate Fauna."

(R.) signifies that the species was recorded in 1869 by Robertson in the British Association Report, 1869.

An asterisk after these letters (M.*, etc.) signifies that the species was recorded in these author's papers, but has not been found by us.

---

## SYSTEMATIC LIST OF SPECIES.

---

### Sub-Kingdom **PROTOZOA.**

### Class RHIZOPODA.

### Order *FORAMINIFERA.*

---

#### Family MILIOLIDÆ.

1. *Nubecularia lucifuga* Defrance, pl. V. figs. 1, 2. (Refs., B. 1884, F.C. p. 134; H-A. & E. 1915, F.K.A. p. 549.) At Station I, extremely well-grown specimens, including a remarkable individual which we figure, in which the final chamber is separated into two distinct tubular outgrowths, bearing the apertures, suggesting Roboz' figures of *Calcituba polymorpha*.* Distribution: Station I, r.; Stations II, V, v.r. (M.)

2. *Biloculina depressa* d'Orbigny. (Refs., B, 1884, F.C. p. 145.) I, v.c.; II, III, IV, V, IX, v.r. (M.) (P.)

3. *B. ringens* (Lamarck). (Refs., H-A. & E. 1915, F.K.A. p. 550.) (P.✱)

4. *B. elongata* d'Orbigny, pl. V. figs. 3–5. (Refs., B. 1884, F.C. p. 144.) We figure a large specimen from Station I as *B. elongata* owing to its general contour. It might, however, on account of its large aperture, have been equally well recorded as *B. ringens* d'Orb. Worth records *B. ringens* var. *patagonica* Williamson, which is a synonym of *B. elongata* d'Orb. (M.) (P.) (R.)

5. *B. irregularis* d'Orbigny. (Refs., B. 1884, F.C. p. 140.) I, v.r.

6. *B. tubulosa* Costa. (Refs., B. 1884, F.C. p. 147.) (P.✱) Worth records this with some reservation, but it is a well-marked form and not uncommon in moderately deep water off the S.-W. of Ireland.

7. *Spiroloculina grata* Terquem. (Refs., B. 1884, F.C. p. 155; H-A. & E. 1915, F.K.A. p. 552.) Single specimens at I, IV, V, VIII.

8. *S. excavata* d'Orbigny. (Refs., B. 1884, F.C. p. 151; H-A. and E. 1915, F.K.A. p. 554.) I, II, III, v.r.; IV, VII, VIII, v.r.; V, f.; X. (P.)

9. *S. dorsata* Reuss. (Refs., H-A. & E. 1915, F.K.A. p. 554.) The specimens are very weak and hardly distinguishable from *S. planulata*. (M., P. and R. as *S. limbata*.) I, v.r.

10. *S. planulata* (Lamarck). (Refs., B. 1884, F.C. p. 148.) I, II, III, VII, VIII, v.r. (M.) (P.) (R.)

10*a*. *S. fragilissima* d'Orbigny. (Refs., H-A. & E. 1915, F.K.A. p. 587.) (P.✱) A tropical form.

---

* Z. v. Roboz, *Calcituba polymorpha*, g. n. et sp. n., Sitzb. Ak. Wiss. Wien., lxxxviii. (1883) p. 420.

11. *Miliolina circularis* (Bornemann.) (Refs., H-A. & E. 1915, F.K.A. p. 557.) Universally distributed. At many stations the specimens were very thin-shelled and translucent. Chitinous tests at Stations III and V. (P.)

12. *M. circularis* var. *sublineata* Brady. (Refs., H-A. & E. 1915, F.K.A. p. 558.) I, v.r.

13. *M. labiosa* (d'Orbigny). (Refs., H-A. & E. 1915, F.K.A. p. 559.) I, v.r.

14. *M. subrotunda* (Montagu), pl. V. figs. 6–8. (Refs., B 1884, F.C. p. 168; H-A. & E. 1915, F.K.A. p. 559.) Universally distributed. At many of the stations very thin and translucent specimens. At Station III, where the species was well represented, there were a few individuals of a hauerine type, which we figure. (M.) (P.) (R.)

15. *M. seminuda* (Reuss). (Refs., H-A. & E. 1915, F.K.A. p. 560.) Generally distributed. Best at V, and most frequent at IX.

16. *M. sub-orbicularis* (d'Orbigny). (Refs., H.-A. & E. 1898, etc., S.B. 1911, p. 304.) VI, v.r.

17. *M. trigonula* (Lamarck). (Refs., B. 1884, F.C. p. 164.) As a rule very small specimens. II, III, V, VII, IX, v.r. (M.) (P.)

18. *M. tricarinata* (d'Orbigny). (Refs., B. 1884, F.C. p. 165; H-A. & E. 1915, F.K.A. p. 562.) I, III, v.r.; V, r. (M.) (P.)

19. *M. bosciana* (d'Orbigny). (Refs., H-A. & E. 1915, F.K.A. p. 566.) Generally distributed.

20. *M. oblonga* (Montagu). (Refs., B. 1884, F.C. p. 160; H-A. & E. 1915, F.K.A. p. 566.) Universally distributed. At Stations I, II, V and VII, Williamson's stoppered or operculate variety (W. 1858, R.F.G.B. p. 86, pl. vii. figs. 186, 187) occurs in company with the normal milioline type of Montagu. At the remaining stations the normal type only was found. (M.) (P.) (R.)

21. *M. pygmæa* (Reuss). (Refs., H-A. & E. 1915, F.K.A. p. 567.) V, f. (M. as *M. tenuis* (Czjzek), and M. 1906 as *Sigmoilina tenuis*.)

22. *M. rotunda* (d'Orbigny). (Refs., H-A. & E. 1915, F.K.A. p. 568.) A single typical specimen at Station II.

23. *M. seminulum* (d'Orbigny). (Refs., B. 1884, F.C. p. 157.) Universally distributed. An unusual form of distortion was observed at Station IV, the last two chambers being formed with their axes at right angles to that of the earlier chambers, thus projecting from the middle portion of the shell and presenting the aperture of the antepenultimate chamber in the middle of the test. (M.) (P.) (R.)

24. *M. candeiana* (d'Orbigny). (Refs., H-A. & E. 1913, C.I. p. 29, and 1916, F.W.S. p. 212, pl. xxxix, figs. 19–27.) This very obscure species is found in great numbers at Station I, and presents a greater range of variation than we have observed elsewhere. In the early stages it is often distinctly spiroloculine in the arrangement of its chambers, the milioline form not being assumed until the specimens have attained a considerable size (five to six chambers). Its affinities still remain very uncertain, and, as we have observed elsewhere, the type specimens on which the species was originally recorded as British are nowhere to be found. I, v.c.; II, f.; IV, V, VI, IX, v.r. (M.)

25. *M. auberiana* (d'Orbigny). (Refs., H-A. & E. 1915, F.K.A. p. 571.) Universally distributed.

26. *M. fusca* Brady. (Refs., H-A. & E. 1915, F.K.A. p. 576.) Frequent and finely developed at V, single specimens only at III and VI. (And on Millett's slides III*c*.)

27. *M. contorta* (d'Orbigny). (Refs., H-A. & E. 1915, F.K.A. p. 576.) Generally distributed, and presenting every variation from very rounded to acutely angular forms.

28. *M. sclerotica* (Karrer). (Refs., H-A. & E. 1915, F.K.A. p. 577.) Generally distributed, and the same remarks as in the previous species apply as to variation. As to the difficulty of separating these two species, see our Clare Island Monograph (H-A. & E. 1913, C.I. p. 30). (M.)

29. *M. stelligera* (Schlumberger). (Refs., H-A. & E. 1913, C.I. p. 31.) I, II, III, IV, VIII, and IX, v.r.

30. *M. ferussacii* (d'Orbigny) (Refs., H-A. & E. 1915, F.K.A. p. 578.) Common at Station I, where it presents a great range of variation and attains a large size. The largest specimens are so flattened as to be almost spiroloculine. II, III, VII, VIII, IX, v.r.

31. *M. agglutinans* (d'Orbigny). (Refs., H-A. & E. 1915, F.K.A. p. 575.) (P. ✱)

32. *M. lævigata* (d'Orbigny). (Refs., H-A. & E. 1916, F.W.S. p. 214.) A good range from adelosine to mature individuals. Frequent at V*b*, I, II, VII, VIII, IX, r.; X.

33. *M. bicornis* (Walker & Jacob). (Refs., B. 1884, F.C. p. 171; H-A. & E. 1915, F.K.A. p. 580.) Very poorly represented, the specimens being but feebly striate. I, r.; II, III, v.r.; V, f. Adelosine stages at III and V. (P.)

34. *M. pulchella* (*bicornis*) var. *elegans* Williamson (W. 1858, R.F.G.B. p. 88, pl. viii, fig. 195.) This appears to be merely a regular and delicately striate variety of *M. bicornis*. (P. ✱)

35. *M. boueana* (d'Orbigny). (Refs., B. 1884, F.C. p. 173.) (P.✱) Another and more compact form of *M. bicornis*.

36. *M. brongniartii* (d'Orbigny). (Refs., H-A. & E. 1915, F.K.A. p. 580.) Large and typical at several stations, especially at Station IV, and on the whole much more representative than its ally, *M. bicornis*. Universally distributed. (M.)

37. *M. pulchella* (d'Orbigny). (Refs., H-A. & E. 1915, F.K.A. p. 578.) (M.✱) Very rarely found in shore-sands, and as a British form very rare even in dredgings.

38. *Massilina secans* (d'Orbigny). (Refs., B. 1884, F.C. p. 167; and H-A. & E. 1915, F.K.A. p. 582.) Universally distributed. (P.) (M.)

39. *M. secans* var. *tenuistriata* Earland. (Refs., H-A. & E. 1915, F.K.A. p. 582.) II, III, V, VII, v.r.

40. *M. secans* var. *denticulata* Costa. (Refs., H-A. & E. 1908, etc.; S.B. 1910, p. 694.) Single typical specimens at II and V.

41. *Opthalmidium carinatum* (Balkwill & Wright). (Refs., H-A. & E. 1913, C.I. p. 34.) I, f.; II, v.r.

42. *Planispirina clarensis* Heron-Allen and Earland. (H-A. & E., C.I. p. 35, pl. ii, figs. 7, 8.) A single individual at Station V of this species, which we recorded for the first time, from Clare Island.

43. *Cornuspira foliacea* (Philippi). (Refs., B. 1884, F.C. p 199; H-A. & E. 1915, F.K.A. p. 592.) Occurs of a large size at Station I both of the original type of Philippi and in Williamson's evolute form. (W. 1858, R.F.G.B. p. 91, pl. vii, figs. 199, 200.) A single specimen at Station VIII. (M.) (P.) (R.)

44. *C. selseyensis* Heron-Allen & Earland. (Refs., H-A. & E. 1915, F.K.A. p. 592.) I, f.; II, IX, r.; III, c.; IV*b*, VIII*b*, v.r.

45. *C. involvens* (Reuss). (Refs., H-A. & E. 1908, etc.; S.B. 1909, p. 318; and 1915, F.K.A. p. 593.) Generally distributed, but never common. (M.) (P.)

Family ASTRORHIZIDÆ.

46. *Iridia diaphana* Heron-Allen & Earland. (H-A. & E. 1914, F.K.A. p. 371; and 1915, p. 608.) Occurs at Station I, young individuals only in the hemispherical attached condition, and at Station V fully grown forms were found.

## *Iridia diaphana* H-A. & E.

The synonomy of this species, which is apparently of world-wide distribution, and represents one of the simplest and most primitive forms of Arenaceous Foraminifera, is rapidly growing, and, under the International Rules of Zoological Nomenclature,* becomes with each newly-discovered record more complicated. Owing to the wide variability of the test, and the differing degrees of importance assigned by earlier authors to certain features in the construction of the shell,† it appears, in one or other of its life-stages, to have been described under more than one name.

We have already dealt with the matter at some length elsewhere,‡ in connexion with an abnormal form growing between sand-grains, and described by Rhumbler in 1905 as *Vanhoefenella gaussi*,§ and which we figured in our Kerimba Monograph; ‖ but as regards the British specimens, the present appears to be a favourable opportunity for reviewing the situation.

In order to deal with the matter fully, we must go back to 1854, when Schultze instituted the genus *Squamulina*,¶ which is thus described:—"Shell resembling a flat plano-convex lens with the plane side firmly attached, calcareous, enclosing a simple undivided space. A large aperture on the convex side; no fine perforations." He includes the genus, with the genera *Gromia* and

* See Report of the IXᵉ Congrès International de Zoologie, Monaco, Mars, 1913.

† For the tests of this organism one is tempted to make use of the German equivalent "house" (*Gehäuse*).

‡ H-A. & E. 1915, F.K.A. pt. 2, p. 608.

§ H-A. & E., in Proc. Zool. Soc. (Lond.) 1915, p. 296. Rhumbler's original description was published in Verh. d. Deutsch. Zool. Ges. 1905, p. 105, fig. 9, and he gives a further description and figures in his "Foraminiferen des Plankton Expedition der Humboldt Stiftung," iii. L.C., Kiel and Leipzig, pt. 1, 1909, p. 216, text-fig. 57.

‖ H-A. & E., 1914, F.K.A. pl. xxxvi. fig. 10.

¶ S. 1854, O.P. p. 56, pl. vi. figs. 16, 17.

*Lagynis*, in a family, Lagynidæ. *Squamulina lævis*, the type, is thus described:—"Shell irregularly circular, very flat, the convex half thick, exteriorly smooth; the plane side very thin, and with difficulty separable from the foreign bodies to which it is firmly attached. The yellowish animal protrudes numerous pseudopodia (*Fortsätze*) from a large eccentrically placed aperture. Greatest diameter 0·26 mm." Bütschli in 1889 * places the genus with *Nubecularia*, following Carpenter, who placed it with the Miliolidæ.†

Carter in 1870,‡ disregarding the *calcareous* definition of *Squamulina*, placed two new species in the genus, *S. scopula*—which is only a synonym for *Haliphysema tumanowiczii* Bowerbank—and *S. varians*, which is described as "white, more or less circular, plano-convex, raised or depressed, . . . presenting all kinds of forms." Carter's figures are very diagrammatic and not of much use for identification purposes, but his species *S. varians* appears to be a composite of two distinct forms, which he describes as the "elevated convex form" and the "amœboid form." There is no evident connexion between the two, and the magnifications attached to his figures are opposed to any such connexion. The "amœboid form" is unquestionably the same organism as that subsequently recorded and described by us, doubtfully, from Bognor and Selsey Bill as *Thurammina papillata* Brady (?) §, and later assigned by us to the new genus *Iridia* H-A. & E.‖

The "elevated convex form," although suggestive of the hemispherical early stage of *Iridia* recorded and figured, also doubtfully, by us from Selsey Bill as *Webbina hemisphærica* J. P. & B.,¶ differs in many material points:—(1) its far greater convexity: it is more than a hemisphere; (2) its extraordinarily symmetrical and prominent aperture, which is funnel-shaped, and described as widening outwards, sometimes crescentic and lateral, at others produced in a circular form on a short neck; (3) its rough spicular exterior; (4) its basal flange of attachment, to which Carter appears to attach considerable importance; (5) its very thick shell-wall; and (6) its large size as compared with the young stage of *I. diaphana*.

Brady, in his "Synopsis," ** includes Carter's species under *Placopsilina* as *P. varians* (Carter), and as a synonym includes *P. kingsleyi* Siddall.†† He says: "I am not prepared to say what

* O. Butschli, in Bronn's "Klassen und Ordnungen des Thierreichs," edn. 1889, i. p. 188.

† C. P. & J. 1862, I.F. p. 67, pl. i. fig. 22 (after Schultze).

‡ C. 1870, S. pp. 310 and 321, pl. v. figs. 1–5.

§ E. 1905, F.B.S. p. 201, pl. xi. figs. 6, 7; pl. xiv. figs. 1–3; and H-A. & E. 1908, etc., S.B. 1909, p. 323.

‖ H-A. & E. 1914, F.K.A. pt. 1, p. 371, pl. xxxvi.

¶ H-A. & E. 1908, etc.: S.B. 1909, p. 325, pl. xv. fig. 14.

** B. 1887, S.B.R.F. p. 890.

†† S. 1886, F.L.M.B.C. p. 54, pl. i. fig. 1.

is the precise position and relationship of this organism, but I believe Mr. Siddall's specimens to belong to the species described many years ago by Mr. Carter under the name *Squamulina varians* and treated by him as a near ally of *Haliphysema tumanowiczii*, with which it is often found associated." * The Siddall Collection is now in our possession, but the type of *P. kingsleyi* is missing. Siddall's only description of the type is "a double-chambered form which seems intermediate between *P. bulla* Brady and *P. cenomana* d'Orbigny." The figure is extremely poor, but suggests the latter species. The type of Siddall's other record "*Placopsilina* spp. d'Orb.," dredged by Mr. A. O. Walker off Hilbre Island, is in the collection and is obviously an attached Gromia.

In any case, Brady's allocation of Carter's *S. varians* to *Placopsilina* will not hold, the generic differences being too great. Millett records *Placopsilina varians* (Carter) in a MS. list of "Recent Foraminifera of Marazion, Mounts Bay, supplied to Prof. Jas. Clark, 4th March, 1906." This specimen is not, of course, in the Millett Collection now in our possession, but another mount labelled "*P. varians*, Broadsand, Torbay," is in the collection, which is *Iridia diaphana* of the same form as the Bognor and Selsey specimens. There is also a slide labelled "*P. bulla* ?*Webbina hemisphærica*" (no locality) which is clearly the young, depressed, hemispherical, early stage of our species.

Carter's allocation of his species to Schultze's genus cannot stand, owing to the admitted differences in the nature of the test. The specimens cannot be placed with *Placopsilina*, having nothing in common with that genus except the rough exterior of the test, and, moreover, possessing certain generic features such as the chitinous lining and basal membrane of attachment which are not found in *Placopsilina*.

Carter's specimens must therefore be assigned to our genus *Iridia*, which is based on these special features. The "elevated convex form," which appears to be quite distinctive, must retain Carter's specific name and be known as *I. varians* (Carter), and his "amœboid form," which is identical with our type species, must become *I. diaphana*.†

Since the above was written our views have been confirmed by the finding of numerous specimens, identical in size, construction and appearance with Carter's *I. varians*, growing on the roots of *Laminaria* at l'Etacq in the N.W. of Jersey in company with both species of *Haliphysema*.

* This is undoubtedly the case. A slide in the Millett Collection now in our possession contains an algal fragment covered with specimens of *H. tumanowiczii* and its basal plates, and also undoubted specimens of the organism under consideration.

† H-A. & E. 1914, F.K.A. pl. xxxvi. figs. 6-12.

47. *Hyperammina vagans* Brady. (Refs., H. A. & E. 1915, F.K.A. p. 610.) A single specimen at VIII*a*.

48. *Haliphysema ramulosa* Bowerbank. (Refs., B. 1884, F.C. p. 283.) (M. 1906.)

49. *H. tumanowiczii.* (Refs., B 1884, F.C. 281.) Both of these species were found upon Laminarian roots from Marazion (Station III) in the Millett Collection. We were not able to collect any suitable material for such sessile forms, and did not observe any detached fragments, but there is no doubt that they are to be found all along the south Cornish coast in suitable localities. (M.) (P.)

## Family LITUOLIDÆ.

50. *Reophax difflugiformis* Brady. (Refs., H-A. & E. 1915, F.K.A. p. 612.) Typical specimens from Station I. On the slides from Marazion (Station III*c*) in the Millett Collection are several specimens which appear from the large and broad aperture to be *Difflugia pyriformis* Perty* rather than *R. difflugiformis*. If so, they are no doubt fresh-water specimens washed down by land water. (M.)

51. *R. scorpiurus* Montfort. (Refs., B. 1884, F.C. p. 291.) (M. ✱) Very rare in shore-sands.

52. *R. findens* (?) (Parker). (Refs., H-A. & E. 1913, C I. p. 44.) (M.✱) It is more than likely that this record, to which Millett appends a note of interrogation, was *R. moniliforme* Siddall (S. 1886, F.L.M.B.C. p. 54, pl. i. fig. 2). This latter species was included under *R. findens* in Siddall's River Dee paper (Proc. Chester Nat. Sci. Pt. 2, 1878, p. 42), and *R. moniliforme* was not separated by him until 1886. Millett's Marazion specimen is unfortunately lost.

53. *R. scottii* Chaster. (Refs., H-A. & E. 1913, C.I. p. 44.) The specimens (from Station I) are small compared with the Scottish types and more strongly constructed, fine sand being used in addition to the usual mica flakes, but in the number and shape of the chambers the specimens are quite typical.

54. *Haplophragmium canianum* Heron-Allen & Earland. (H-A. & E. 1916, F.W.S p. 224, pl. xl, figs. 15–18.) A few typical specimens from Station V of this form recently described by us from the West of Scotland.

55. *H. fontinense* Terquem. (Refs., H-A. & E. 1908, etc.; S.B. 1910, p. 405.) (P. ✱)

---

* Cf. J. Leidy, Fresh-water Rhizopods of North America. Washington, 1879, p. 98, pl. x.

---

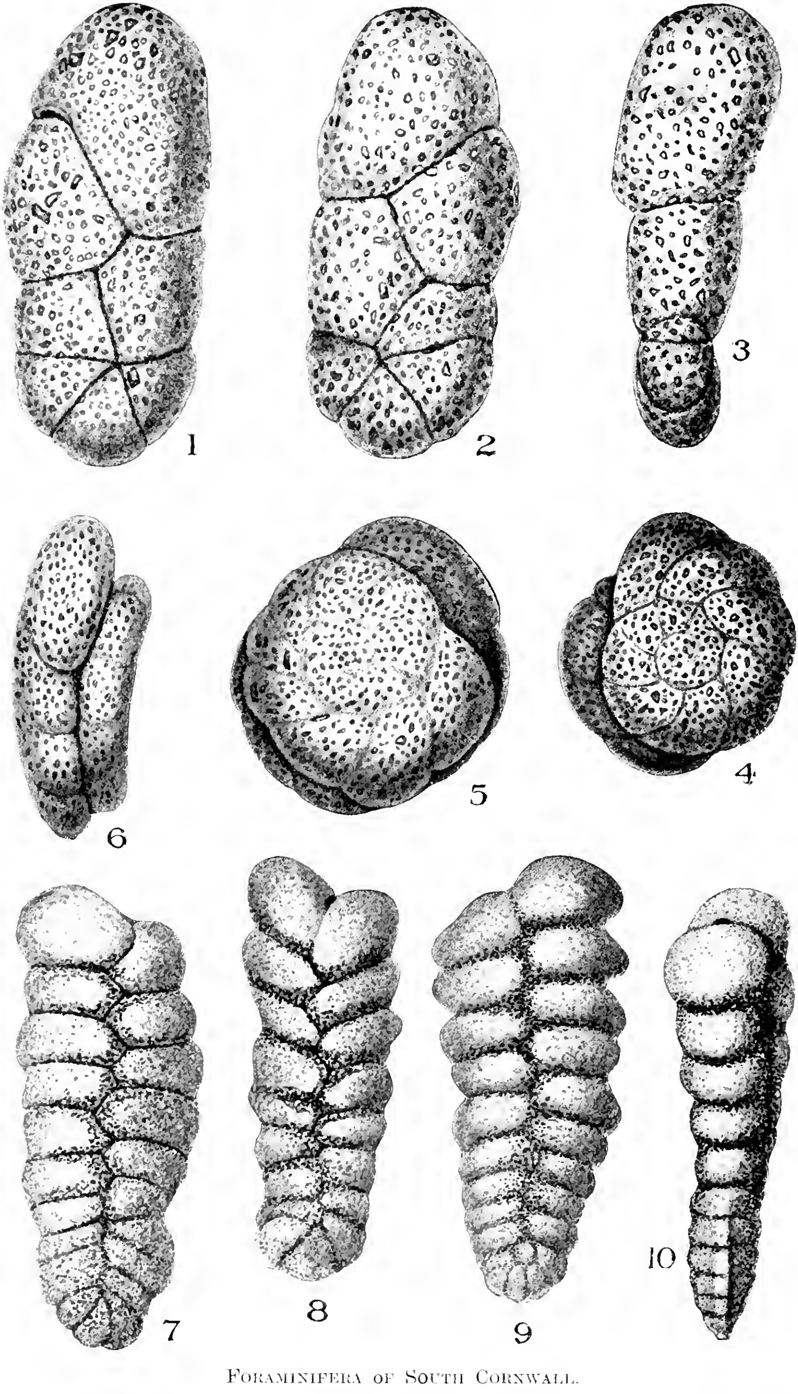
## EXPLANATION OF PLATE VI.

FIGS.

1–3. —*Haplophragmium canariense* var. *variabilis* nov. Figs. 1, 2, side views. Fig. 3, edge view. × 110.

4–6. —*Trochammina squamata* (Jones & Parker). Double specimens. Figs. 4, 5, side views. Fig. 6, edge view. × 150.

7–10.—*Spiroplecta wrightii* Silvestri. Figs. 7–9, side views. Fig. 10, edge view × 65.




Foraminifera of South Cornwall.

[Face p. 40.

56. *H. canariense* (d'Orbigny). (Refs., B. 1884, F.C. p. 310; and H-A. & E. 1915, F.K.A. p. 614.) Universally distributed and exhibiting all the typical variations of the species. (R.) (P) (M.)

57. *H. canariense* var. *variabilis* nov. (Plate VI, figs. 1–3.) At Station I. abnormal individuals in which the original evolute spiral is followed by a succession of three or more chambers arranged on a textularian plan similar to some individuals of *Truncatulina variabilis* d'Orbigny, such as have been figured by Brady (B 1884, F.C. pl. xciii. fig. 7), and Sidebottom (S. 1901, etc., R.F.D. 1909, p. 3, pl. ii, figs. 1–3). The occurrence of this dimorphous form in *Haplophragmium* and *Truncatulina* is additional proof, if such be required, of the artificial nature of the distinctions between the perforate and arenaceous Foraminifera. We have recorded this variety, but without naming it, from the West of Scotland. (H-A. & E. 1916, F.W.S. p. 223.)

58. *H. globigeriniforme* (Parker & Jones.) (Refs., H-A. & E. 1915, F.K.A. p. 614.) I, r.; II, IV, VI, v.r. (M.) (P.)

58A. *Placopsilina varians* (Carter). See note to No. 46, *Iridia diaphana* H-A. & E.

59. *Ammodiscus incertus* (d'Orbigny). (Refs., B. 1884, F.C. p. 330.) I, III, v.r. (P.)

60. *A. gordialis* (Jones & Parker). (Refs., H-A. & E. 1915, F.K.A. p. 618.) I, III, IV, V, VII, VIII*a*, v.r. (M.) (P.)

61. *Trochammina squamata*. (Plate VI, figs. 4–6.) (Jones & Parker.) (Refs., H-A. & E. 1915, F.K.A. p. 619.) I, f.; II, V, IX, v.r.; X. At Station I, where the species was frequent, double or "budding" specimens, some of which we figure, were found, a phenomenon with which we have dealt elsewhere (H-A. 1915, R.P.F. pp. 246–7). (M.)

62. *T. ochracea* (Williamson). (Refs., H-A. & E. 1915, F.K.A. p. 619.) I, IV, V*a*, VIII*a*, IX, v.r. (M.) (P.)

63. *T. plicata* (Terquem). (Refs. H-A. & E. 1915, F.K.A. p. 619.) I, r.; II, v.r. (M.)

64. *T. inflata* (Montagu). (Refs., B. 1884, F.C. p. 338; H-A. & E. 1915, F.K.A. p. 620.) III, v.r.; V, f.; X. (M.) (P.) (R.)

65. *T. inflata* var. *macrescens* Brady. (Refs., H-A. & E. 1913, C.I. p. 52.) Single individuals at Stations V*b* and IX.

66. *T. rotaliformis* Wright. (Refs., H-A. & E. 1915, F.K.A. p. 620.) I, f.; II, III, V, v.r.

## Family TEXTULARIIDÆ.

67. *Textularia sagittula* Defrance. (Refs., B. 1884, F.C. p. 361, pars.; H-A. & E. 1915, F.K.A. p. 625.) Extremely rare compared with the abundance of its isomorph *Spiroplecta wrightii*, q.v. I, IV, VII, v.r. (R.) (P.) (M.)

68. *T. agglutinans* d'Orbigny. (Refs., B. 1884, F.C. p. 363; H-A. & E. 1915, F.K.A. p. 626.) I, r. (P.)

69. *T. agglutinans* var. *porrecta* Brady. (Refs., H-A. & E. 1915, F.K.A. p. 627.) (P.*)

70. *T. candeiana* d'Orbigny. (Refs., H-A. & E. 1915, F.K.A. p. 627.) I, r.

71. *T. gramen* d'Orbigny. (Refs., H-A. & E. 1915, F.K.A. p. 627.) Generally distributed. Nearly all the specimens show characteristics intermediate between *T. gramen* and *T. conica*. (M.) (P.)

72. *T. conica* d'Orbigny. (Refs., H-A. & E. 1915, F.K.A. p. 629.) Universally distributed.

73. *T. trochus* d'Orbigny. (Refs., H-A. & E. 1915, F.K.A. p. 630.) The specimens are large and quite typical. I, r.; IV, f. (P.)

74. *Verneuilina polystropha* (Reuss). (Refs., B. 1884, F.C. p. 386.) Curiously rare in these gatherings. I, II, VIII *b*, IX, v.r.; V, f.; X. (M.) (P.)

75. *Spiroplecta wrightii* Silvestri. Plate VI. figs. 7–10. (Refs H-A. & E. 1915, F.K.A. p 634.) Extraordinarily abundant at Station 1, and subject to remarkable variations, one of the most notable, which we figure, being the transition in the latter half of the shell to inflated chambers presenting a lobulate marginal edge. The marginal edge is, however, rounded, and in this respect differs from specimens of *S. wrightii* which we possess in the Millett Collection from the Gulf of Oman, in which the marginal edge of such chambers is produced to a sharp point, suggesting the *Textularia mariæ* of d'Orbigny (d'O. 1846, F.F.V. p. 246, pl. xiv. figs. 29–31), which, however, is described as having a punctate shell. I, v.c.; II, f.; IV, VII, v.r.

76. *Gaudryina filiformis* Berthelin. (Refs. H-A. & E. 1915, F.K.A. p. 634.) I, V, IX, v.r.

77. *G. rudis* Wright. (Refs., H-A. & E. 1916, F.W.S. p. 232.) I, f.; IV, v.r. (M.)

78. *Valvulina fusca* (Williamson). (Refs., B. 1884, F.C. p. 392.) Specimens both free and attached at Station 1.

79. *Clavulina obscura* Chaster. (Refs., H-A. & E. 1913, C.I. p. 59.) I, c.; IV, IX, v.r.

80. *Bulimina pupoides* d'Orbigny. (Refs., H-A. & E. 1915, F.K.A. p. 637.) Generally distributed. (R.) (P.) (M).

81. *B. elongata* d'Orbigny. (Refs., H-A. & E. 1908, etc.; S.B. 1909, p. 333.) I, VII, v r. At Station VII a specimen was found, apparently a derived Eocene fossil.

82. *B. elegans* d'Orbigny. Plate VII. fig. 1. (Refs., H-A. & E. 1915, F.K.A. p. 638.) Generally distributed. At Station VIII an abnormal specimen was found, which we figure, in which a second individual had budded at mid-growth from another, the budded individual being developed on very much more robust lines than the original or parent shell. (P.)

83. *B. elegans* var. *exilis* Brady. (Refs., H-A. & E. 1916, F.W.S. p. 234.) (P. ✱)

84. *B. marginata* d'Orbigny. (Refs., H-A. & E. 1908, etc.; S B. 1911, p. 312.) I, II, IV, VIII, IX, v.r. (M.) (P.)

85. *B. aculeata* d'Orbigny. (Refs., B. 1884, F.C. p. 406.) (M. ✱) This is a doubtful record for a shore-sand, and was probably *B. marginata* with a terminal spine, which is not uncommon in these gatherings. (P. ✱) This is more likely to be a reliable record, as Worth's specimens were dredged from moderately deep water.

86. *B. fusiformis* Williamson. (Refs., H-A. & E. 1908, etc.; S.B. 1911, p. 312.) Remarkably fine and well-developed specimens. I, IV, f.; VIII, v.r.

87. *B. ovata* d'Orbigny. (Refs., H-A. & E. 1915, F.K.A. p. 638.) I, IV, v.r. (M.) (R.)

88. *B. elegantissima* d'Orbigny. (Refs., B. 1884, F.C. p. 402; H-A. & E. 1915, F.K.A. p. 639.) I, VIII*b*, v.r. At Station IV paired or "budded" individuals were found. (Cf. H-A. 1915, R.P.F. p. 248, pl. xv. fig. 28*a–f*.) (M.) (P.)

89. *B. minutissima* Wright. (Refs., H-A. & E. 1913, C.I. p. 62.) I, II, v.r.

90. *B. subteres* Brady. (Refs., H-A. & E. 1908, etc.; S.B. 1911, p. 314.) I, v.r.

91. *B. squammigera* d'Orbigny. (Refs., H-A. & E. 1915, F.K.A. p. 642.) I, v.r.

92. *B. convoluta* Williamson. (Refs., H-A. & E. 1915, F.K.A. p. 641.) A few typical specimens of the very elongate type at Station I.

93. *Virgulina schreibersiana* Czjzek. (Refs., H-A. & E. 1915, F.K.A. p. 642.) I, II, v.r. (M.) (P.)

94. *Bolivina punctata* d'Orbigny. (Refs., B. 1884, F.C. p. 417.) Universally distributed. (M.) (R.) (P.)

95. *B. nobilis* Hantken. (Refs., H-A. & E. 1908, etc.; S.B. 1909, p. 335.) II, v.r.

96. *B. textilarioides* Reuss. (Refs., H-A. & E. 1915, F.K.A. p. 645.) I, III, V*b*, VIII*c*, v.r. (P.)

97. *B. lævigata* (Williamson). (Refs., H-A. & E. 1908, etc.; S.B. 1909, p. 335.) I, II, III, IX, v.r. The best specimens at Station IX. (M.)

98. *B. dilatata* Reuss. (Refs., H-A. & E. 1915, F.K.A. p. 645.) I, II, f.; III, IV, IX, v.r. (P.) In Millett's list he records *Textularia pygmæa* d'Orbigny (Modèle No. 7), which is obviously a *Bolivina*; and Millett, in Parker, Jones, and Brady's "Monograph of the Foraminifera of the Crag" (Pal. Soc. 1866–97), identifies it as *B. dilatata*, which does not appear in his Mount's Bay list.

99. *B. ænariensis* (Costa). (Refs., H-A. & E. 1908, etc.; S.B. 1909, p. 334.) Single specimens from Station IX and from the worm tubes at Station III*b*. (P.)

100. *B. difformis* (Williamson). (Refs., H-A. & E. 1915, F.K.A. p. 645.) I, II, r. (M. sub. *Textularia*.) (P.)

101. *B. tortuosa* Brady. (Refs., H-A. & E. 1915, F.K.A. p. 645.) I, v.r.

102. *B. variabilis* (Williamson). (Refs., H-A. & E., 1915, F.K.A. p. 647.) Generally distributed.

103. *B. plicata* d'Orbigny. (Refs., H-A. & E. 1908, etc.; S.B. 1909, p. 335.) Generally distributed. (M.)

104. *B. inflata* Heron-Allen & Earland. (Refs., H-A. & E. 1915, F.K.A. p. 648.) I, II, IV, V*b*, VI, VIII, v.r.

This specific name illustrates very well some of the difficulties with which the Rules of Nomenclature are intended to deal. Since we described the species in our Clare Island Monograph (H-A. & E. 1913, C.I.) we have discovered that Andreæ in 1884 used the same trivial name for a form which he called *Textularia inflata*. Since Andreæ's specimen was undoubtedly a *Bolivina*, it might have been called *B. inflata*, but it is, as a matter of fact, identical with the previously described *B. punctata*, of which the name would therefore become a synonym. This, however, cannot prejudice our subsequent use of the name *B. inflata*, since Andreæ's name was from the first a homonym of *Textularia inflata* Ehrenberg, 1854. Consequently there would never have been any such collocation as *B. inflata* (Andreæ), and therefore there is nothing of which *B. inflata* H-A. & E. can be a homonym.

105. *Cassidulina lævigata* d'Orbigny. (Refs., H-A. & E. 1915, F.K.A. p. 652.) (M.✱)

106. *C. crassa* d'Orbigny. (Refs., B. 1884, F.C. p. 429.) I, c.; II, f.; IV, V*b*, IX, v.r. (M.) (P.) Millett records *C. oblonga* Reuss; this is virtually *C. crassa*, from which it differs very little, if at all.

107. *C. subglobosa* Brady. (Refs., H-A. & E. 1913, C.I. p. 70.) I, c.; III, f.; V*b*, IX, v.r.

108. *C. bradyi* Norman. (Refs., H-A. & E. 1915, F.K.A. p. 653.) (P.✱)

109. *C. nitidula* (Chaster). (Refs., H-A. & E. 1915, F.K.A. p. 653.) Common at Station I, the specimens being large and finely typical.

## Family LAGENIDÆ.

110. *Lagena globosa* (Montagu) (Refs., B. 1884, F.C. p. 452; H-A. & E. 1915, F.K.A. p. 654.) Very abundant, universally distributed, and the specimens often attaining a very large size. There is always some uncertainty whether these abnormally large specimens are true *Lagenæ*, or primordial chambers of *Polymorphinæ*. As they are often more or less compressed, or irregular in shape, it seems probable that they are not *Lagenæ*. Individuals of true *L. globosa* with double apertures were recorded at Stations I and VIII*a*, and feebly sulcate specimens at Stations I and V. (M.) (P.) (R.)

111. *L. hispida* Reuss. (Refs., H-A. & E. 1908, etc.; S.B. 1911, p. 319.) (P.✱)

112. *L. aspera* Reuss. (Refs., H-A. & E. 1915, F.K.A. p. 655.) Two quite typical specimens from Station I. (M.) (P.)

113. *L. lineata* (Williamson). (Refs., H-A. & E. 1908, etc.; S.B. 1911, p. 320; and 1915, F.K.A. p. 656.) I, c.; II, IV, VIII, IX, v.r. Subject to extraordinary variations at Station I, where it was abundant. At this station, elongate, curved, and pedunculate forms occurred, and also an individual with two separate terminal portions. The specimens also present an extraordinary range in their surface markings, from practically a smooth surface to coarse striæ, whilst always preserving the general characteristics of the species. (P.) (M. as *L. caudata* Parker & Jones.) (M. 1906 = *L. lineata* (Williamson).)

114. *L. hexagona* (Williamson). (Refs., B. 1884, F.C. p. 472.) Generally distributed. (M.) (P.)

115. *L. reticulata* (Macgillivray). (Refs., H-A. & E. 1915, F.K.A. p. 656.) I, IX, v.r.; II, f. (M. 1906.)

116. *L. squamosa* (Montagu). (Refs., B. 1884, F.C. p. 471.) Generally distributed. (M.) (P.)

## EXPLANATION OF PLATE VII.

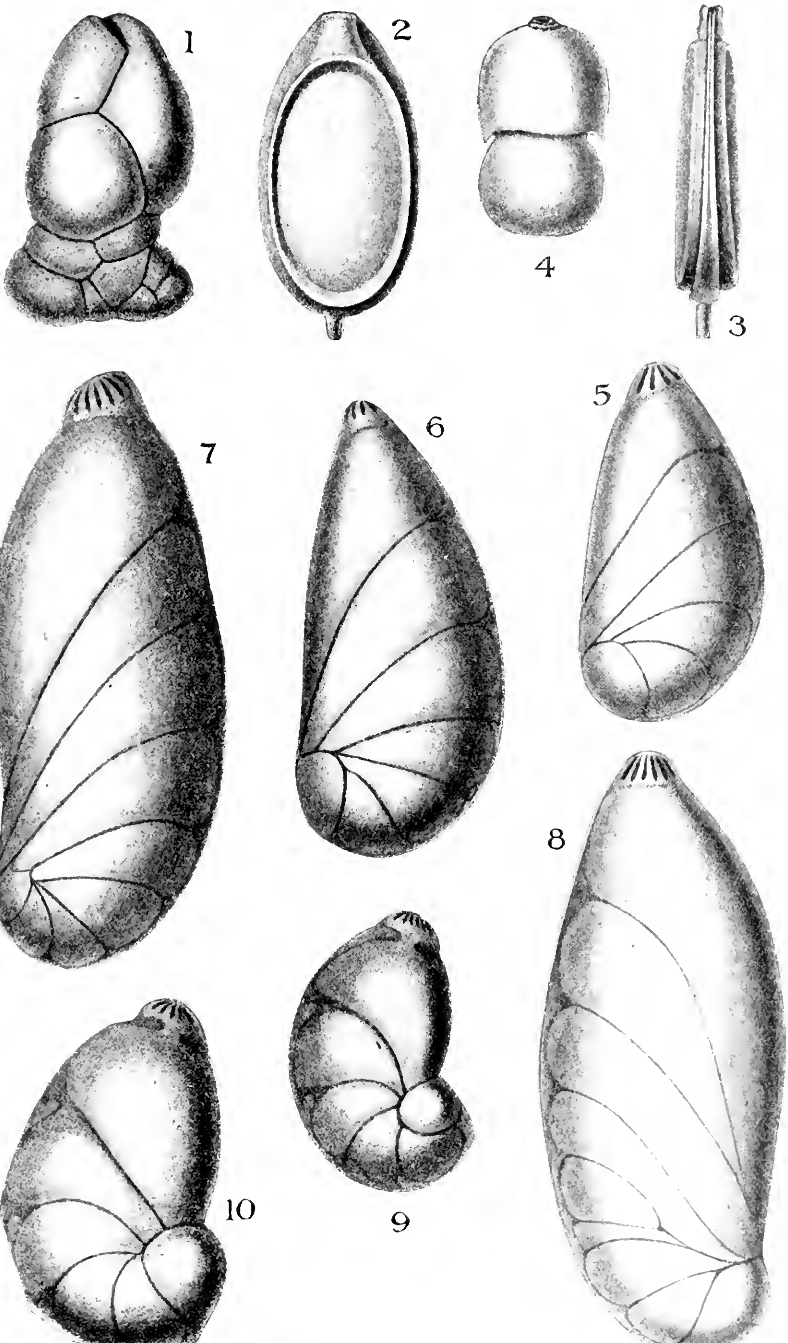
FIGS.

1.—*Bulimina elegans* d'Orbigny. Double shell. × 110.

2–3.—*Lagena bicarinata* Terquem. Fig. 2, side view. Fig. 3, edge view. × 150.

4.—*Lingulina pellucida* Sidebottom. Side view. × 150.

5–10.—*Cristellaria crepidula* (Fichtel & Moll). Side views. × 75.




FORAMINIFERA OF SOUTH CORNWALL.

[Face p. 14.

117. *L. squamosa* var. *montagui* (Alcock). (Refs., H-A. & E. 1913, C.I. p. 76.) I, v.r.; II, f.

118. *L. melo* (d'Orbigny). (Refs., M. 1898, etc.; F.M. 1901, p. 8.) (M.✱) This is an extremely rare form, but Millett was well acquainted with its specific distinctions, and his record is verified by the existence of specimens on his Marazion slides.

119. *L. botelliformis* Brady. (Refs., M. 1898, etc.; F.M. 1901, p. 192.) (P.✱)

120. *L. lævis* (Montagu). (Refs., B 1884, F.C. p. 455.) I, II, v.r. (M.) (P.) (R.)

121. *L. semistriata* Williamson. (Refs., B. 1884, F.C. p. 465.) I, c.; II, f.; IV, v.r.; V*b*, r. (M.) (P.) (R.)

122. *L. perlucida* Williamson. (Refs., H-A. & E. 1913, C.I. p. 78.) I, v.r.

123. *L. striata* (d'Orbigny). (Refs., B. 1884, F.C. p. 460.) I, II. v.r. (M.) (P.) (R.)

124. *L. curvilineata* Balkwill & Wright. (Refs., H-A. & E. 1913, C.I. p. 78.) (M.✱) This species was recorded in 1885 from the Irish Sea (B. & W. 1885, D.I.S. p. 338, pl. xiv. figs. 21–24), but it appears in Balkwill & Millett's Galway paper in 1884 (B. & M. 1884, F.G. p. 27, pl. ii. fig. 3), and in the Revision (1908). The Galway figure is not true, *L. curvilineata* (which is near *L. striata* in the character of its markings), but is a distorted *L. sulcata*. Such specimens are not uncommon in these gatherings (see No. 126), and no doubt the Mount's Bay and Galway specimens were similar. Millett's Malay figure (M. 1898, etc., F.M. 1901, p. 488, pl. viii. fig. 5) represents the same unsatisfactory form.

125. *L. distoma* Parker & Jones. (Refs., B. 1884, F.C. p. 461.) (P.✱)

126. *L. sulcata* (Walker & Jacob). (Refs., B. 1884, F.C. p. 462.) Generally distributed. As is usually the case in shore-sands the species is very variable and subject to distortion. Compressed and inæquilateral specimens occur, and also individuals in which the sulci are irregularly spiral in their arrangement. We have not separated Williamson's var. *interrupta* (W. 1858, R.F.G.B. p. 7, pl. i. fig. 11), in which alternate sulci are discontinuous, which occurs at several stations. (M.) (P.) Worth separates Williamson's var. *interrupta* as a distinct variety.

127. *L. lyellii* (Seguenza). (Refs., H-A. & E. 1915, F.K.A. p. 659.) I, v.r. (M.)

128. *L. williamsoni* (Alcock). (Refs., H-A. & E. 1915, F.K.A. p. 659.) Generally distributed. (M.)

129. *L. costata* (Williamson). (Refs., H-A. & E. 1908, etc.; S.B. 1911, p. 321.) I, v.r. (M. 1906.)

130. *L. clavata* (d'Orbigny). (Refs., H-A. & E. 1915, F.K.A. p. 660.) I, II, III, v.r. (M.) (P.)

131. *L. gracillima* (Seguenza). (Refs., H-A. & E. 1908, etc.; S.B. 1911, p. 319). I, v.r. (M.) (P.)

132. *L. gracilis* (Williamson). (Refs., H-A. & E. 1916, F.W.S. p. 248.) I, v.r. (P.)

133. *L. lævigata* (Reuss). (Refs., B. 1884, F.C. p. 473; H-A. & E. 1915, F.K.A. p. 661.) I, IV, VIII*a*, f.; II, III, v.r. (M. 1906.)

134. *L. acuta* (Reuss). (Refs., H-A. & E. 1915, F.K.A. p. 661.) I, r.; II, f. (M.)

135. *L. millettii* Chaster. (Refs., H-A. & E. 1913, C.I. p. 83.) I, v.r.

136. *L. lucida* (Williamson). (Refs., H-A. & E. 1915, F.K.A. p. 661.) Generally distributed. Trigonal forms occur, and at Station I an abnormal specimen quadrangular in section. (M.) Millett also records *L. trigono-oblonga* (no author) which was probably a trigonal specimen of *L. lucida*. Such trigonal forms were recorded by Seguenza as *Trigonulina oblonga* (S. 1862, F.M.M.M. p. 74, pl. ii. figs. 56 and 58). The institution of a new species *L. trigono-oblonga* is therefore clearly superfluous. (Cf. also J. Wright, Recent Foraminifera of Down & Antrim, Proc. Belfast, Nat. Field Club, 1876-7, App. IV, p. 104, pl. iv. fig. 8.)

136A. *L. faba* Balkwill & Millett. (Refs., H-A. & E. 1913, C.I. p. 84.) (M. 1906.)

137. *L. annectens* Burrows & Holland. (Refs., H-A. & E. 1915, F.K.A. p. 662.) I, r.; VIII*b*, v.r.

138. *L. quadrata* (Williamson). (Refs., H-A. & E. 1908, etc.; S.B. 1911, p. 321.) I, r.; IV, V*a*, v.r. (M.) (P.)

139. *L. quadrata* var. *semi-alata* Balkwill & Millett. (B. & M. 1884, F.G. p. 31, pl. ii fig. 9.) (M. ✱)

140. *L. malcomsonii* Wright. (Refs., H-A. & E. 1915, F.K.A. p. 662.) I, v.r.

141. *L. marginata* (Walker & Boys). (Refs., B. 1884, F.C. p. 476.) Generally distributed. (M.) (P.) Millett also records as a new species *L. trigono-elliptica*. (Cf. B. & M. 1884, F.G. p. 81, and Revision (1908), p. 8, pl. iii. fig. 8.) It is merely a trigonal form of *L. marginata*, and is so recorded in the Revision. He also records *L. trigono-marginata* from Mounts Bay as a distinct species, and Worth (P.) records it from the Plymouth area.

142. *L. marginata* var. *inæquilateralis* Wright. (Refs., H-A. & E. 1913, C.I. p. 85.) I, V, r.

143. *L. unguis* Heron-Allen & Earland. (H-A. & E. 1913, C.I. p. 86, pl. vii. figs. 1–3). I, III, v.r.

144. *L. marginato-perforata* Seguenza. (Refs. H-A. & E. 1915, F.K.A. p. 663.) IX, v.r.

145. *L. lagenoides* (Williamson). (Refs., H-A. & E. 1915, F.K.A. p. 665.) I. f.; II, IV, v.r. (M.) (P.)

146. *L. lagenoides* var. *tenuistriata* Brady. (Refs., H-A. & E. 1916, F.W.S. p. 252.) (M. 1906.) I, v.r. (M. as *L. tenuistriata*.)

147. *L. ornata* (Williamson). (Refs., H-A. & E. 1913, C.I. p. 88.) I, v.r. (P.)

148. *L. formosa* Schwager. (Refs., H-A. & E. 1913, C.I. p. 88.) At Station I a very few specimens of this form, hitherto only found in British waters by us at Clare Island.

149. *L. bicarinata* (Terquem). Plate VII, figs. 2, 3. (Refs., H-A. & E. 1915, F.K.A. p 665.) I, f.; II, v.r. Very fine specimens, including pedunculate individuals, which we figure, at Station IV.

150. *L. rizzæ* (Seguenza). (Refs., H-A. & E. 1915, F.K.A. p. 666.) I, II, VIII*a*, v.r.

151. *L. orbignyana* (Seguenza). (Refs., B. 1884, F.C. p. 484; H-A. & E. 1915, F.K.A p. 666.) Universally distributed and generally abundant. Nearly all the specimens are of an equally biconvex type, but a form with compressed parallel faces occurs in company with the other at Stations II and V, at which stations trigonal specimens occurred, all of the biconvex type. (M.) (P.)

152. *Nodosaria radicula* (Linné). (Refs., B. 1884. F.C. p. 495.) One small but typical specimen at Station I.

153. *N. calomorpha* Reuss. (Refs., H-A. & E. 1908, etc.; S.B. 1911, p. 322.) (P. ✱)

154. *N. scalaris* (Batsch). (Refs., B. 1884, F.C. p. 510.) I, r.; II, III, VIII*a*, v.r. (M.) (P.)

155. *N. proxima* Silvestri. (Refs., H-A. & E. 1915, F.K.A. p. 669.) A single typical specimen at Station I.

156. *N. pyrula* d'Orbigny. (Refs, B. 1884, F.C. p. 497.) I, II, V, v.r. The species is mainly represented by fragments, but some of these must have formed part of specimens of very large size. (M.) (P.)

157. *N. communis* d'Orbigny. (Refs., B. 1884, F.C. p. 504.) I, v.r. (M.) (P.) (R.)

158. *N. obliqua* (Linné). (Refs., B. 1884, F.C. p. 513.) (M. ✱)

159. *Lingulina pellucida* Sidebottom. Plate VII, fig. 4. (Refs., H-A. & E. 1913, C.I. p. 96.) A single specimen at Station I, which is probably referable to this species, although the earlier of the two chambers is larger than is represented in Sidebottom's original figure, or in our subsequent Clare Island record. The present is the second British record, and the third British locality in which it has been found, the other being a 'Goldseeker' dredging in the Moray Firth. Millett, in his Malay Papers, figures (M. 1898, etc.; F M. 1902, p. 523, pl. xi. fig. 15), a biloculine *Lingulina* which he called *L. limbata*, and, referring in the text to Sidebottom's Delos form *L. pellucida*, states that he has specimens and drawings of that form, and that it is closely allied to his own species *L. limbata*, but not identical. He appears, however, to have altered his mind on this point subsequently, as the Delos specimens of *L. pellucida* Sidebottom in his collection are identified by him as *L. limbata* Millett. We do not agree with this later view of Millett's; the two forms appear to be quite distinct, though no doubt closely allied.

160. *Marginulina costata* (Batsch). (Refs., B. 1884, F.C. p. 528.) A single good specimen from Station I.

161. *Vaginulina legumen* (Linné). (Refs., B. 1884, F.C. p. 530.) I, V, VII, VIII*b*, v.r.

162. *Cristellaria crepidula* (Fichtel & Moll). Plate VII, figs. 5–10, and Plate VIII, fig. 1. (Refs., B. 1884, F.C. p. 542.) This is the most representative Cristellarian in the district, and at Station I specimens were not only numerous, but presented extreme varieties. Many of the forms figured by Burrows and Holland (B. & H. 1897, P.B p. 39, pl. i. figs. 1–21) occur at this station, and it would have been possible to have compiled quite a long list of varietal names, but where the range of individuals is so great in a single locality it seems undesirable to do this. Zoologically they are all referable to the single type, and we figure some of the more striking forms. At the remaining stations (shore-sands) all the individuals were of the normal type, though varying greatly in size. I, f.; II, r.; III, IV, V, v.r. (M.) (P.) (R.)

163. *C. italica* (Defrance). (Refs., B. 1884, F.C. p. 544.) (P. ✱) A deep-water species.

164. *C. hauerina* d'Orbigny. (d'O. 1846, F.F.V. p. 84, pl. iii. figs. 24, 25.) Plate VIII, figs. 2–4. (New to Britain.) At Station I a single typical specimen of the evolute or uncoiled type of this very variable species. Although not previously recorded in Britain (at any rate as a recent form), there can be no question as to the recent character of this specimen, the shell being in the most perfect hyaline condition. The *C. rhomboidea* of Czjzek (C 1848, F.W.B. p. 141, pl. xii. figs. 21–23) is another form of this protean species.

165. *C. rotulata* (Lamarck). (Refs., B. 1884, F.C. p. 547.) Generally distributed. The specimens are larger and better developed than is usual in shore-sands. (M.) (P.) (R.)

166. *C. vortex* (Fichtel & Moll.) (Refs., B. 1884, F.C. p. 548.) (P. ✱) A Mediterranean and tropical species.

167. *Cristellaria cultrata* (Montfort). (Refs., B. 1884, F.C. p. 550.) I, II, V, VII, v.r. The same observation applies to this species as to No 165.

168. *Amphicoryne falx* (Jones & Parker). (Refs., M. 1898, etc.; F.M. 1903, p. 260.) (P. ✱)

169. *Polymorphina sororia* Reuss. (Refs., H-A. & E. 1915, F.K.A. p. 673.) I, c.; III, Va, v.r., IV, r.

170. *P. amygdaloides* Reuss. (Refs., B. 1884, F.C. p. 560.) I, r.

171. *P. lactea* (Walker & Jacob). (Refs., B. 1884, F.C. p. 559.) Generally distributed. (R.) (P.) (M.)

172. *P. concava* Williamson. (Refs., H-A. & E. 1913, C.I. p. 102.) I, f.; VII, v.r. With a few exceptions all the specimens were free. (M.)

173. *P. oblonga* Williamson. (Refs., H-A. & E 1915, F.K.A. p. 672.) At Station I it is frequent and attains a comparatively gigantic size, the largest *Polymorphina* found in the gatherings. There is a tendency in the larger specimens to the formation of the last chambers on a plane differing from that of the preceding ones. (M.) (P.) (R.)

174. *P. complexa* Sidebottom. Plate VIII, figs. 5–7. (New to Britain.) (Refs., H-A. & E. 1915, F.K.A. p. 673.) At Station I, a single specimen, which we figure, which appears to be referable to Sidebottom's species, though differing by the absence of the cribrate aperture which characterized the Delos forms. The specimen has the characteristic overlapping sutural margins, but no visible apertures.

175. *P. gibba* d'Orbigny. (Refs., B. 1884, F.C. p. 561.) I, IV, V, VI, VII, v.r. (M.) (P.)

176. *P. æqualis* (M. ✱) This is probably intended for *P. æqualis* (d'Orbigny) (d'O. 1846, F.F.V. p. 227, pl. xiii. figs. 11, 12, Reuss's Model No. 52), which is a compressed form of *P. gibba*.

177. *P. myristiformis* Williamson. (Refs., H-A. & E. 1908, etc ; S.B. 1909, p. 134.) Very abundant and large at Station I, presenting great variation, including the quasi-bilocular form figured by us from Clare Island. Much smaller and more normal at Stations II and IV. (M.) (R.)

178. *P. communis* d'Orbigny. (Refs., B. 1884, F.C. p. 568.) I, VI, VII, VIII, v.r. (M.)

---

EXPLANATION OF PLATE VIII.

FIGS.

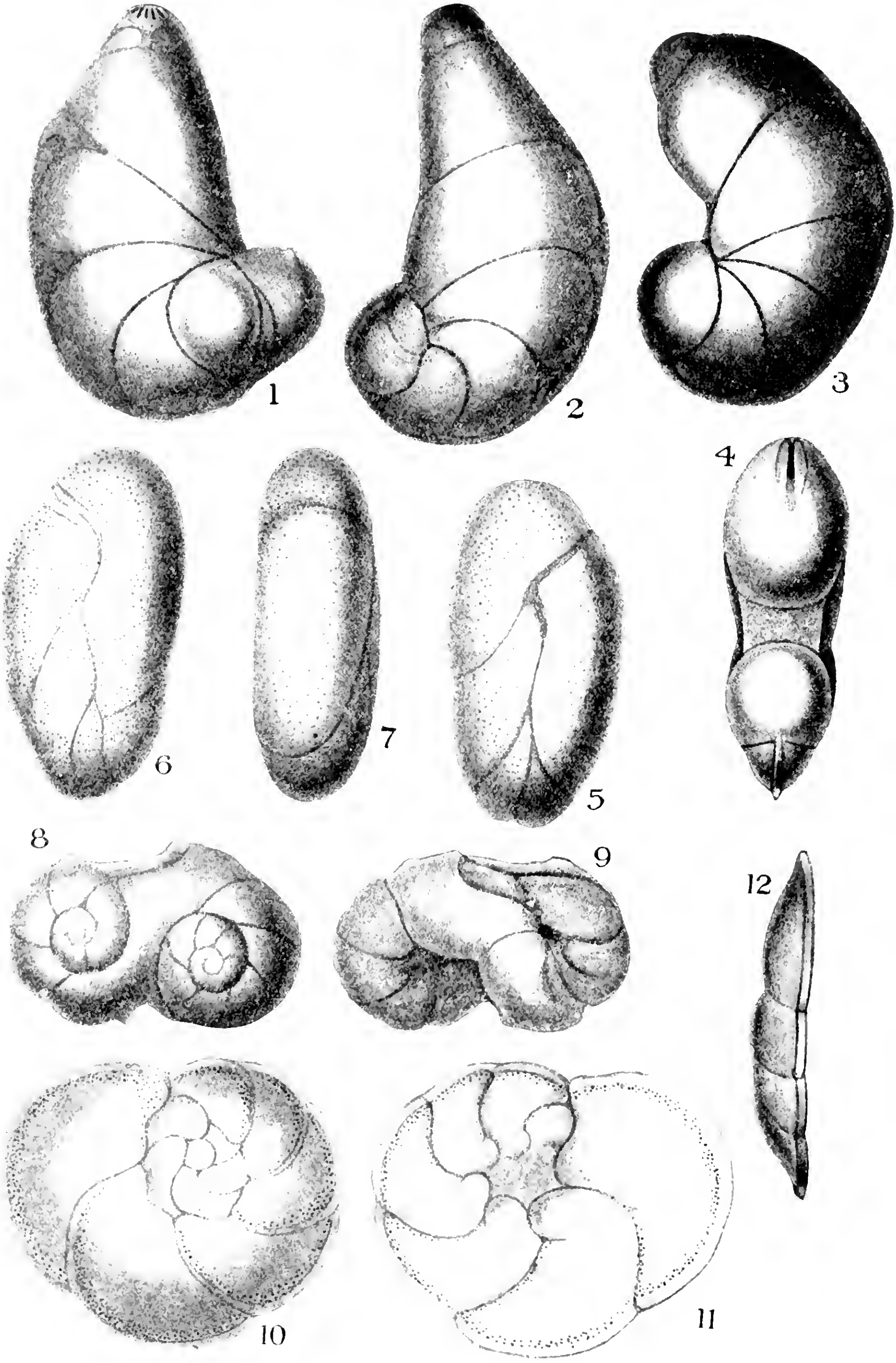
1.—*Cristellaria crepidula* (Fichtel & Moll). Abnormal specimen with two primordial chambers. × 75.

2–4.—*C. hauerina* d'Orbigny. Figs. 2, 3, side views. Fig. 4, edge (oral) view. × 85.

5–7.—*Polymorphina complexa* Sidebottom. Figs. 5, 6, side views. Fig. 7, edge view. × 135.

8–9.—*Discorbina globularis* (d'Orbigny). Fusion of two individuals. Fig. 8, superior view. Fig. 9, inferior view. × 110.

10–12.—*D. bertheloti* var. *baconica* Hantken. Fig. 10, superior view. Fig. 11, inferior view. Fig. 12, edge view. × 135.




Foraminifera of South Cornwall.

[Face p. 48.

179. *P. problema* d'Orbigny. (Refs., B. 1884, F.C. p. 568). I, II, v.r.
180. *P. rotundata* (Bornemann). (Refs., B. 1884, F.C. p. 570.) I, V, v.r.
181. *P. compressa* d'Orbigny. (Refs., B. 1884, F.C. p. 565; H-A. & E. 1915, F.K.A. p. 672.) Generally distributed, and frequently common. (M.) (P.) (R.)

NOTE.—It is noteworthy that in spite of the abundance of the genus *Polymorphina* in the gatherings, no fistulose specimens were found.

182. *Uvigerina angulosa* Williamson. (Refs., H-A. & E. 1915, F.K.A. p. 676.) Generally distributed. (P.) (M.)

## Family GLOBIGERINIDÆ.

183. *Globigerina bulloides* d'Orbigny. (Refs., B. 1884, F.C. p. 593.) I, II, r.; IV, V*b*, v.r. (M.) (P.)
184. *G. inflata* d'Orbigny. (Refs., B 1884, F.C. p. 601.; H-A. & E. 1915, F.K.A. p. 679.) I, II, III, v.r. (M ) (P.)
185. *G. rubra* d'Orbigny. (Refs., H-A. & E. 1915, F.K.A. p. 679.) I, c.; IV, v.r.

NOTE.—The Globigerinidæ are very sparingly represented, and the specimens were uniformly weak and small.

186. *Orbulina universa* d'Orbigny. (Refs., B. 1884, F.C p. 608.) Specimens of the small thick-walled type at Station I only. (P.) (R.)
187. *Sphæroidina dehiscens* Parker & Jones. (Refs., B. 1884, F.C. p. 621.) (P. ✱) A tropical form, but a single specimen has been previously recorded from the Dee Estuary (S. 1886, F.L.M.B.C. p. 58).

## Family ROTALIDÆ.

188. *Spirillina vivipara* Ehrenberg. (Refs., H-A. & E. 1915, F.K.A. p. 683.) I, II, c.; III, V*b*, v.r.; IV, r. (R.) (P.) (M.) Extremely variable both in size and general characteristics.
189. *S. obconica* Brady. (Refs., H-A. & E. 1915, F.K.A. p. 683.) I, v.r.
190. *S. obconica* var. *carinata* Halkyard. (Refs., H-A. & E. 1913, C.I. p. 108.) I, II, r.
191. *S. limbata* Brady. (Refs., H-A. & E. 1915, F.K.A. p. 684.) I, II, v.r.
192. *S. limbata* var. *denticulata* Brady. (Refs., H-A. & E. 1913, C.I. p. 109.) I, r.
193. *S. margaritifera* Williamson. (Refs., H-A. & E. 1915, F.K.A. p. 685.) I, f. (M.) (P.) (R.)
194. *Patellina corrugata* Williamson. (Refs., H-A. & E 1915, F.K.A. p. 686.) Generally distributed, often abundant and of large size. Both the circular and the oval types described by us from Clare Island (H-A. & E. 1913, C.I. p. 110) occur. (M.) (P.) (R.)
195. *Discorbina nitida* (Williamson). (Refs., H-A. & E. 1908, etc.; S.B. 1911, p. 328.) Universally distributed and often attaining a large size, especially at Station V. Every degree of variation in the height of the spire and the development of the marginal edge occurs. In some cases the entire absence of carina and a tendency to inflation

of the chambers results in a lobulate peripheral outline. We are figuring this type from the West of Scotland. (H-A. & E. 1916, F.W.S. p. 269, pl. xlii. figs 29, 30.) (M. and P. as *Rotalia nitida.*)

196. *D. millettii* Wright. (Refs., H-A. & E. 1913, C.I. p. 121.) I, f.; II c.; III, V*b*, VII, VIII, v.r.

197. *D. prægeri* Heron-Allen & Earland. (Refs., H-A. & E. 1915, F.K.A. p. 692.) I, c; III, V*a*, r.; IV, VI, IX, v.r.

198. *D. rosacea* (d'Orbigny). (Refs., H-A. & E. 1915, F.K.A. p. 692.) Generally distributed. (M.) (P.)

199. *D. peruviana* (d'Orbigny). (Refs., H-A. & E. 1913, C.I. p. 122.) I, v.c.; II, c.; IV, f; III, r.; VIII*a*, v.r.

200. *D. mamilla* (Williamson). (Refs., H-A. & E. 1915, F.K.A. p. 693.) Universally distributed.

201. *D. planorbis* (d'Orbigny). (Refs., H-A. & E. 1915, F.K.A. p. 693.) I, III, VII, r.; II, v.c.; V*a*, VIII*b*, v.r.; X.

202. *D. turbo* (d'Orbigny). (Refs., H-A. & E. 1915, F.K.A. p. 693.) I, III, VII, IX, v.r.

203. *D. baccata* Heron-Allen & Earland. (Refs., H-A. & E. 1916, F.W.S. 271.) Single specimens at Stations I, II, and VIII*a*, common at Station V, and rare but very fine at Station IX.

204. *D. orbicularis* (Terquem). (Refs., H-A. & E. 1915, F.K.A. p. 693.) Generally distributed. (M.) (P.)

205. *D. mediterranensis* (d'Orbigny). (Refs., H-A. & E. 1915, F.K.A. p. 693.) Universally distributed. At Station IV the specimens constituted 95 p c. of the material.

206. *D. irregularis* Rhumbler. (Refs., H-A. & E. 1913, C.I. p. 120.) I, v.r.; II, c; III, V*a*, f.; IV, v.c.; VIII*a*, r.

207. *D. globularis* (d'Orbigny). Plate VIII, figs. 8, 9. (Refs., B. 1884, F.C. p. 643; H-A. & E. 1915, F.K.A. p. 694.) Universally distributed. A very curious twinned specimen, which we figure, was found at Station II. This is evidently due to the fusion of two individuals which had grown side by side attached to a common host. (M.) (P.) (R.)

208. *D. tuberculata* Balkwill & Wright. (Refs., H-A. & E. 1915, F.K.A. p. 695.) A single typical specimen from Station I.

209. *D. polyrraphes* Reuss. (Refs., H-A. & E. 1913, C.I. p. 128.) I, f.

210. *D. chasteri* Heron-Allen & Earland. (Refs., H-A. & E. 1915, F.K.A. p. 697.) I, c.; IV, V, VIII*a*, v.r. Both the circular and oval types occur, the former predominating.

211. *D. chasteri* var. *bispinosa* Heron-Allen & Earland. (H-A. & E. 1913, C.I. p. 129, pl. xiii. fig. 4.) I, v.r.

212. *D. vesicularis* (Lamarck). (Refs., B. 1884, F.C. p. 651.; H-A. & E. 1915, F.K.A. p. 697.) V, VIII, v.r.

213. *D. bertheloti* d'Orbigny. (Refs., H-A. & E. 1908, etc.; S.B. 1911, p. 327.) I, II, VII, v.r. At Station VII, a large infiltrated fossil specimen similar to the Eocene specimens from Selsey Bill, and probably derived from the same source as the *Bulimina elongata* noticed *supra*. (P.)

214. *D. bertheloti* var. *baconica* Hantken. Plate VIII, figs. 10-12. (New to Britain.) (Refs., B. 1884, F.C. p. 651.) I, v.r.

215. *D. pustulata* Heron-Allen & Earland. (Refs., H-A. & E. 1915, F.K.A. p. 701.) Moderately frequent and quite typical at Station I.

216. *D. parisiensis* (d'Orbigny). (Refs., H-A. & E. 1908, etc.; S.B. 1909, p. 443.). (M.✱) (P.✱)

217. *D. wrightii* Brady. (Refs., H-A. & E. 1915, F.K.A. p. 702.) A single typical specimen at Station IX.

218. *D. obtusa* (d'Orbigny). (Refs., H-A. & E. 1908, etc.; S.B. 1909, p. 442.) I, II, VII, v.r.

219. *Planorbulina mediterranensis* d'Orbigny. (Refs., B. 1884, p. 656.) Universally distributed. (M.) (P.) (R.)

220. *Truncatulina refulgens* (Montfort). (Refs., H-A. & E. 1908, etc.; S.B. 1911, p. 335.) Generally distributed.

221. *T. lobatula* (Walker & Jacob). Plate IX, fig. 1. (Refs., B. 1884, F.C. p. 660.) Universally distributed, and often very common. At Station IV an abnormal specimen was found, which we figure, consisting of two individuals fused together, apex to base, so that the two plane surfaces of the bases are visible in the associated pair. (M.) (P.) (R.)

222. *T. variabilis* d'Orbigny. (Refs., B. 1884, F.C. p. 661; H-A. & E. 1915, F.K.A. p. 706.) Generally distributed with *T. lobatula* where that species is common.

223. *T. haidingerii* d'Orbigny. (Refs., B. 1884, F.C. p. 663; H-A. & E. 1915, F.K.A. p. 708.) I, III, v.r.

224. *T. ungeriana* (d'Orbigny). (Refs., B. 1884, F.C. p. 664; H-A. & E. 1915, F.K.A. p. 708.) Generally distributed.

225. *T. reticulata* (Czjzek). (Refs., H-A. & E. 1908, etc.; S.B. 1911, p. 336.) At Station V*b*, two typical examples of this form, which is extremely rare in British gatherings.

226. *Pulvinulina repanda* (Fichtel & Moll). (Refs., H-A. & E. 1908, etc.; S.B. 1911, p 340.) I, f.; IV, v.r. (P.)

227. *P. repanda* var. *concamerata* (Montagu). (Refs., H-A. & E. 1908, etc.; S.B. 1911, p. 340.) IV, v.r.

228. *P. punctulata* (d'Orbigny). (Refs., H-A. & E. 1908, etc.; S.B. 1909, p. 683.) The specimens are larger and better developed than are usually found in British shallow waters. I, f.; II, r.

229. *P. concentrica* Parker & Jones. (Refs., H-A. & E. 1915, F.K.A. p. 714.) I, V, v.r.; II, r.

230. *P. auricula* (Fichtel & Moll). (Refs., H-A. & E. 1915, F.K.A. p. 714.) I, c.; IV, v.r. (M.)

231. *P. oblonga* (Williamson). (Refs., H-A. & E. 1915, F.K.A. p. 714.) I, c.; II, IV, v.r.

231A. *P. haliotidea* Heron-Allen & Earland. (Refs., H-A. & E. 1913, C.I. p. 136.) III*c*, v.r.

232. *P. menardii* (d'Orbigny). (Refs., H-A. & E. 1915, F.K.A. p. 715.) (P.✱) Normally a tropical Atlantic and Pacific form.

233. *P. patagonica* var. *scitula* Brady. Plate IX, figs. 2–5.
*Rotalina patagonica* d'Orbigny, 1839, F.A.M. p. 36, pl. ii. figs. 6–8.
*Pulvinulina scitula* Brady, 1882, B.K.E. p. 716.
*P. scitula* Balkwill & Millett, 1884, F.G. p. 85; pl. iv. fig. 12.
*P. patagonica*. Ibid. Revision, 1908, p. 4.
*Discorbina* sp. (?). Halkyard, 1889, R.F.J. p. 70, pl. ii. fig. 11.
*P. patagonica* Heron-Allen & Earland, 1913, C.I. p. 137, pl. xiii. figs. 5, 6.

A few specimens of the form which we figured from Clare Island under this name at Station I. The finding of these additional

specimens does not throw much light on the difficulties with which we were confronted in dealing with the single individual from the Irish coast. While still of opinion that it is a *Pulvinulina*, its identity with d'Orbigny's type *Rotalina patagonica* (d'O. 1839, F.A.M. p. 36, pl. ii, figs. 6–8) appears rather more doubtful. Halkyard figures under the name *Discorbina* sp. (H. 1889, R.F.J. p. 70, pl. ii. fig. 11) some individuals which are unquestionably the same as our form. He states that his specimens had been submitted to Brady, who had identified them with "a weak depauperated form figured by O. Terquem in his Dunkerque Monograph, which paper I have not seen, and therefore cannot give the specific name which M. Terquem gives to this Foraminifer." The only form of Terquem which can be compared with our type is his *Rotalina excavata* (T. 1875, etc. A.P.D. p. 123, pl. xv. fig. 5). This has a similarly large loop-like or pulvinuline aperture, but is much higher in the dome and has more visible chambers. Brady, in 1882 (*ut supra*), describes under the name *Pulvinulina scitula* sp. n., "A variety of *P. canariensis* (d'Orbigny) differing from the typical form in its relatively small size and compact habit of growth. The margin is rounded instead of sharp, and the peripheral ends (*sic* = edges) of the chambers are only slightly convex instead of standing out prominently, as in *P. canariensis*. Notwithstanding its small minute dimensions, it generally attracts attention by its glistening white appearance. Longer diameter, 0·01." Halkyard's types, which are preserved in the University Museum at Manchester, have been examined by us, and prove to be identical with our form.

No figure was published by Brady, but the description of its appearance leaves very little doubt in our minds that this is the Clare Island form. Balkwill and Millett, in their original Galway paper (*ut supra*), figure a specimen of *P. scitula* which is stated to have been identified by Brady, and which, broadly speaking, is intermediate between *P. patagonica* (typical) and our Clare Island figure. In the revision of the Galway paper by Millett (Penzance, 1908) the name *P. scitula* is withdrawn and *P. patagonica* substituted, with a statement that the form had been figured as *P. scitula* "on the faith of Brady, but subsequently he convinced himself that it was identical with *P. patagonica*."

The Clare Island and Cornish specimens are so distinctive as compared with d'Orbigny's original figure, that it seems desirable that Brady's name should be revived as a variety of *P. patagonica*, and we have accordingly adopted this course.

234. *P. karsteni* (Reuss). (Refs., H-A. & E. 1916, F.W.S. p. 276, pl. xlii. figs. 34–37.) I, c.; II, v.r. We have discussed the question of the British records of this species in our West of Scotland paper. The specimens in the Millett Collection entirely confirm the views we have there set forth.

235. *P. elegans* (d'Orbigny). (Refs., H-A. & E. 1915, F.K.A. p. 717.) One minute specimen at Station II.

---

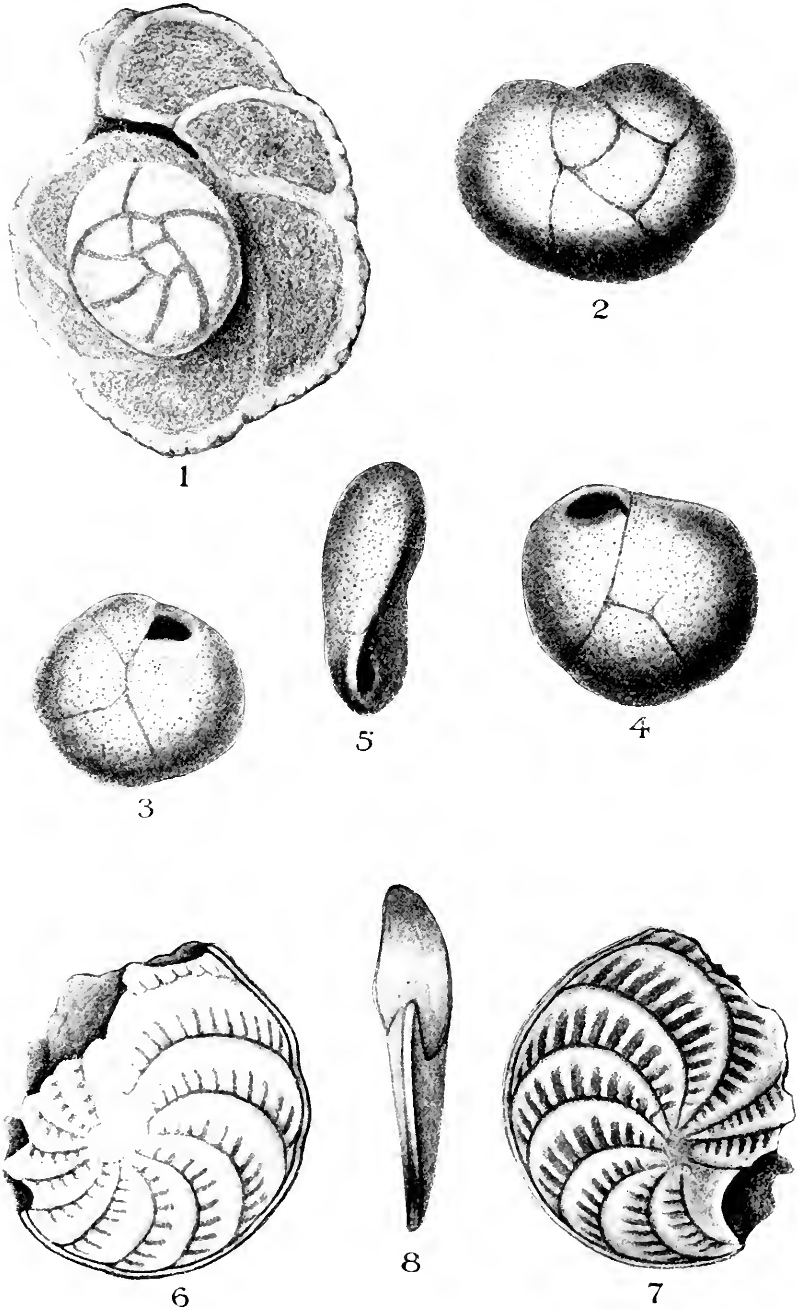
## EXPLANATION OF PLATE IX.

FIGS.

1.—*Truncatulina lobatula* (Walker & Jacob). Double shell. × 110.

2–5.—*Pulvinulina patagonica* var. *scitula* Brady. Fig. 2, superior view. Figs. 3, 4, inferior views. Fig. 5, edge (oral) view. × 135.

6–8.—*Faujasina carinata* d'Orbigny. Fig. 6, inferior view. Fig. 7, superior view. Fig. 8, edge (oral) view. × 110.




FORAMINIFERA OF SOUTH CORNWALL.

[Face p. 52.

236. *Rotalia beccarii* (Linné). (Refs., B. 1884, F.C. p. 704.) Universally distributed. (R.) (P.) (M.)
237. *R. orbicularis* (d'Orbigny). (Refs., H-A. & E. 1915, F.K.A. p. 718.) V, VIII*b*, v.r.; IX, v.c.
238. *R. perlucida* Heron-Allen & Earland. (Refs., H-A. & E. 1915, F.K.A. p. 718.) I, v.r.
239. *Gypsina globulus* (Reuss). (Refs., H-A. & E. 1915, F.K.A. p. 727.). One typical specimen of this species so rarely recorded in British waters at Station IV.
240. *G. vesicularis* (Parker & Jones). (Refs., H-A. & E. 1915, F.K.A. p. 726.) A few specimens at the same station.
241. *G inhærens* (Schultze). (Refs., H-A. & E. 1915, F.K.A. p. 724.) One of the commonest forms in the area, both free and attached. (M.)

## Family NUMMULINIDÆ.

242. *Nonionina depressula* (Walker & Jacob). (Refs., B. 1884, F.C. p. 725; H-A. & E. 1915, F.K.A. p. 730.) Universally distributed. There is less variation in this species throughout the area than usually occurs. Nearly all the stations present a typical form with somewhat turgid chambers and depressed sutural lines. (M.) (P.)
243. *N. umbilicatula* (Montagu). (Refs., H-A. & E. 1915, F.K.A. p. 730.) (M. ✱) (P. ✱)
244. *N. asterizans* (Fichtel & Moll). (Refs., H-A. & E. 1915, F.K.A. p. 730.) Generally distributed. All of the type with the solid umbilical stud. (R.)
245. *N. stelligera* d'Orbigny. (Refs., B. 1884, F.C. p. 728.) I, v.r. Typical specimens. (M.) (P.)
246. *N. scapha* (Fichtel & Moll). (Refs., H-A. & E. 1915, F.K.A. p. 731.) A single specimen at Station II, of a very compressed type, suggesting *N. sloanii* d'Orbigny (d'O. 1839, F.C. p. 46, pl. vi. figs. 18 and 18*b*). (P.)
247. *N. turgida* (Williamson). (Refs., H-A. & E. 1915, F.K.A. p. 731.) (M. 1906 ✱) (P. ✱) Also recorded by Robertson in his Brit. Assoc. List, 1869.
248. *N. pauperata* Balkwill & Wright. (Refs., H-A. & E. 1915. F.K.A. p. 732.) I, c.; II, f.; IV, VI, VIII*a*, IX, v.r.; X. This form, usually very rare, is widely distributed in the area, is frequent at Stations I and II, and attains an unusually large size.
249. *Polystomella striato-punctata* (Fichtel & Moll). (Refs., B. 1884, F.C. p. 733.) Universally distributed, most of the usual types being represented. (M.) (P.)
250. *P. striato-punctata* var. *selseyensis* Heron-Allen & Earland. (Refs., H-A. & E. 1915, F.K.A. p. 733.) III*b*, VII, r.; VIII*b*, c.; IX, f.
251. *P. arctica* Parker & Jones. (Refs., B. 1884, F.C. p. 735.) (P. ✱) A cold-water and arctic form. Recorded by us from Clare Island (H-A. & E. 1913, C.I. p. 146). Worth's record would appear to be the southernmost occurence of the species recorded.
252. *P. crispa* (Linné). (Refs., B. 1884, F.C. p. 736.) Universally distributed. (M.) (P.)
253. *P. faba* (Fichtel & Moll). (Refs., H-A. & E. 1916, F.W.S. p. 281, pl. xliii. figs. 11–19.) X.

254. *P. subnodosa* (Münster). (Refs., H-A. & E. 1915, F.K.A. p. 733.) (P. ✱) Wright has recorded this from south-west Ireland as "frequent."

255. *P. macella* (Fichtell & Moll.) (Refs., B. 1884, P.C. p. 737.) Universally distributed. (P.)

256. *Operculina ammonoides* (Gronovius). (Refs., H-A. & E. 1908, etc. S.B. 1911, p. 697.) · II, v.r.

## Bibliography.


B. 1882, B.K.E.—H. B. Brady, in Tizard and Murray's Exploration of the Faroe Channel during the Summer of 1880, etc. Proc. Roy. Soc. Edinburgh, xi. (1882) pp. 708–17, pl. vi.

B. 1884, F.C.—H. B. Brady. Report on the Scientific Results of the Voyage of H.M.S. 'Challenger' (Zoology) ix. Report on the Foraminifera, 2 vols text and plates, London, 1884.

B. 1887, S.B.R.F.—H. B. Brady. Synopsis of the British Recent Foraminifera. Journ. R. Micr. Soc., 1887. pp. 872–927.

B. & H. 1897, P.B.—H. W. Burrows & R. Holland. The Foraminifera of the Thanet Beds of Pegwell Bay. Proc. Geol. Assoc., xv (1897) pp. 19–52, pls. i.–v.

B. & M. 1884, F.G.—F. P. Balkwill & F. W. Millett. The Foraminifera of Galway. Journ. Micr. and Nat. Sci. (London) iii. (1884) pp. 19–28, 78–90, pls. i.–iv. Revision, F. W. Millett, Plymouth, 1908.

B. & M. 1885, D.I.S.—F. P. Balkwill & F. W. Millett. Report on some Recent Foraminifera found off the Coast of Dublin and in the Irish Sea. Proc. Roy. Irish Acad. (Sci.) xxviii. (1885) pp. 317–68, pls. xii.–xiv.

C. 1848, F.W.B.—J. Czjzek. Beitrag zur Kenntniss der Fossilen Foraminiferen des Wiener Beckens. Haidingers Naturw. Abh. Vienna, ii. (1848) pp. 137–150, pls. xii. xiii.

C. P. & J. 1862, I.F.—W. B. Carpenter, W. K. Parker, & T. R. Jones. Introduction to the Study of the Foraminifera. London (Ray Society), 1862.

C. 1870, S.—H. J. Carter. On Two New Species of the Foraminiferous Genus *Squamulina*, etc. Ann. Mag. Nat. Hist., ser. 4, v. pp. 309–26, pls. iv. v.

E. 1905, F.B.S.—A. Earland. The Foraminifera of the Shore-sand at Bognor, Sussex. Journ. Quekett Micr. Club, ser. 2, ix. pp. 187–232 (pls.).

H. 1889, R.F.J.—E. Halkyard. Recent Foraminifera of Jersey. Trans and Ann. Rep. Manchester Micr. Soc., 1889, pp. 55–72, pls. i. ii.

H-A. 1915, R.P.F.—E. Heron-Allen. Contributions to the Study of the Bionomics and Reproductive Processes of the Foraminifera. Phil. Trans. Roy. Soc. London, Ser. B, ccvi. (1915) pp. 227–279, pls xiii.–xviii.

H-A. & E. 1908, etc., S.B.—E. Heron-Allen & A. Earland. The Recent and Fossil Foraminifera of the Shore-Sands at Selsey Bill, Sussex. Journ. Roy. Micr. Soc. 1908–11 (8 parts).

H.-A. & E. 1913, C.I.—E. Heron-Allen & A. Earland. The Foraminifera of the Clare Island District, Co. Mayo, Ireland. Proc. Roy. Irish Acad. xxxi. (1913.) (Clare Island Survey, Part 64.)

H-A. & E. 1914, F.K.A.—E. Heron-Allen & A. Earland. The Foraminifera of the Kerimba Archipelago (Portuguese East Africa). Part I, Trans. Zool. Soc. London, xx. (1914) pp. 363–390, pls. xxxv.–xxxvii.

H-A. & E. 1915, F.K.A.—E. Heron-Allen & A. Earland. The Foraminifera of the Kerimba Archipelago (Portuguese East Africa). Part II, Trans. Zool. Soc. London, xx. (1915) pp. 543–794, pls. xl.–liii.

H-A. & E. 1916, F.W.S.—E. Heron-Allen & A. Earland. The Foraminifera of the West of Scotland (S.Y 'Runa,' 1913). Trans. Linn. Soc. London (Zoology) xi. (1916) pp. 197–300, pls. xxxix.–xliv.

M. 1898, etc., F.M.—F. W. Millett. Report on the Recent Foraminifera of the Malay Archipelago. Journ. Roy. Micr. Soc. 1898–1904 (17 parts.)

d'O. 1839, F.A.M.—A. D. d'Orbigny. Voyage dans l'Amérique Meridionale. Paris, 1839, v. part 5, Foraminifères.

d'O. 1839, F.C.—A. D. d'Orbigny. 'Foraminifères' in R. de la Sagra, Histoire Physique, etc. de l'Ile de Cuba. Text and Atlas, Paris, 1839.

d'O. 1846, F.F.V.—A. D. d'Orbigny. Foraminifères Fossiles du Bassin Tertiaire de Vienne. Paris, 1846.

S. 1854, O.P.—M. S. Schultze. Ueber den Organismus der Polythalamien (Foraminiferen), etc. Leipzig, 1854.

S. 1862, F.M.M.M.—G. Seguenza. Foraminiferi Monotalamici delle Marne . . . di Messina. Messina, 1862.

S. 1886, F.L.M.B.C.—J. D. Siddall. Report on the Foraminifera of the Liverpool Marine Biological Committee District, Proc. Lit. Phil. Soc. Liverpool, No. 40, Appendix, pp. 42–71, pl. i.

S. 1904, etc. R.F.D.—H. Sidebottom. Report on the Recent Foraminifera from the Coast of the Island of Delos (Grecian Archipelago). Mem. Manchester Lit. & Phil. Soc., xlviii.–liii. (1904–1909) (6 parts).

T. 1875, etc., A.P.D.—O. Terquem. Essai sur le classement des Animaux qui vivent sur la plage et dans les environs de Dunkerque. Paris, 1875–1881 (3 parts).

W. 1858, R.F.G.B.—W. C. Williamson. On the Recent Foraminifera of Great Britain. (Ray Society), London, 1858.

# SUMMARY OF CURRENT RESEARCHES

RELATING TO

# ZOOLOGY AND BOTANY

(PRINCIPALLY INVERTEBRATA AND CRYPTOGAMIA),

# MICROSCOPY, ETC.*

---

## ZOOLOGY.

### VERTEBRATA.

#### a. Embryology.†

**Effect of Radium Rays on Ova.**‡—Charles Packard finds that very mild radiation by means of the gamma rays from 50 mg. of radium bromide produces an acceleration in the rate of cell division in the ova of sea-urchins (*Arbacia punctulata*) without any abnormalities. These rays have no effect on the development of *Nereis limbata*, or of *Drosophila*, the pomace-fly. Moderate stimulation by means of the beta rays, obtained by separating them from the gamma rays in a strong magnetic field, brings about a retardation of growth in *Arbacia* and *Nereis*, followed by no abnormalities. More intense radiation, in which both beta and gamma rays are used, results in a liquefying of the protoplasm in the *Nereis* egg, and the development is abnormal. The eggs of *Arbacia* show no protoplasmic changes, but the chromatin is injured. There is no evidence of parthenogenetic development. Acceleration and retardation may be caused by a change in the rate of enzyme action brought about by the radium treatment.

**Development of Neuraxis of Cat.**§—H. von W. Schulte and Frederick Tilney give an account of the development of the central nervous system of the domestic cat to the stage of twenty-one somites. They deal especially with the interpretation of the forebrain in terms of

* The Society are not intended to be denoted by the editorial "we," and they do not hold themselves responsible for the views of the authors of the papers noted, nor for any claim to novelty or otherwise made by them. The object of this part of the Journal is to present a summary of the papers *as actually published*, and to describe and illustrate Instruments, Apparatus, etc., which are either new or have not been previously described in this country.

† This section includes not only papers relating to Embryology properly so-called, but also those dealing with Evolution, Development, Reproduction, and allied subjects.

‡ Journ. Exper. Zool., xix. (1915) pp. 323-53 (3 pls.).

§ Ann. New York Acad. Sci., xxiv. (1915) pp. 319–46 (20 pls.).

the longitudinal zones of the neural tube, viz. the basal and alar laminæ, and the ganglionic crest. The primitive neural plate in the cat gives rise both to the neural tube and to the ganglionic crest, the latter being a derived and secondary element and not a co-ordinate intermediate between the medullary plate and the somatic ectoderm. In the fore-brain elements equivalent to the ganglionic crest are retained in the wall at the vesicles and constitute the dorsal region of the neural plates, for if the crest secondarily separates from the neural tube, in regions where such separation fails to occur, it is more probable that the crest is included in the brain than that it has been absolutely suppressed. Accordingly the analysis of the prosencephalon is not to be attempted in terms of the basal and alar plates alone, as has been customary since His, but must include a dorsal or "ectal" strip equivalent to the ganglionic crest along its convexity, and this must include at least as much of the brain wall as lies ectal to the optic sulcus. This ganglionic element (the primitive optic vesicle) at four somites forms the cephalic extremity of the neural fold, and arches ventrally to the floor. The optic vesicle and the ectoptic structures, whether above, in front of or below the optic region, must then be considered of ganglionic equivalency, a conclusion which entails a revision of His's analysis of the brain. This the authors proceed to expound.

**Development of Olfactory Nerve.***—Charles Brookover emphasizes the distinctness of the olfactory nerve from other nerves. It is more closely allied in its development to taste-bud components of cranial nerves, but its neurones remain in the ectoderm. It may be that an early development of a protective nasal capsule has lessened the necessity for withdrawal of the neurones from the outside. The development of the nervus terminalis along with the olfactory nerve from the same placode is unique among nerves that are somatic, sensory, or sympathetic. The author refers in particular to his observations on turtle embryos.

**Development of Eye-muscles in Marsupials.**†—Elizabeth A. Fraser has studied the head-cavities and the development of the eye-muscles in *Trichosurus vulpecula* and some other Marsupials. Well-developed premandibular head-cavities are characteristic of the Diprotodontia; they are large in *Trichosurus*, *Phascolarctos*, *Phascolomys* and *Macropus*. In the Polyprotodontia, on the other hand, cavities may be present, as for example in *Perameles*, but only in the form of comparatively small irregular spaces, quite insignificant as compared with those in the former group, or they are altogether absent, as in *Dasyurus*, and probably also in *Didelphys*. The muscles from the first somite then develop from a solid mesodermal mass as in higher Mammals, and not by proliferation from the walls of the premandibular cavity.

That some Marsupials have well-developed premandibular cavities, not as yet observed in other Mammals, shows their apartness, and recalls the conditions existing in some reptiles. The walls of the premandibular cavity, as in most other Vertebrates, give rise to the muscles innervated

* Trans. Amer. Micr. Soc., xxxiv. (1915) pp. 7–20 (5 figs.).
† Proc. Zool. Soc., 1915, pp. 299–346 (2 pls. and 26 figs.).

by the oculomotor nerve. In *Trichosurus*, and probably also in *Phascolomys*, the primordium of the m. obliquus inferior and the common primordium of the mm. rectus inferior and rectus internus develop as solid outgrowths from the posterior and ventral walls, whilst the primordium of the m. rectus superior arises from the walls of a hollow evagination on the dorso-lateral side, the latter mode of origin resembling that of all the oculomotor muscles in *Lacerta*. In *Phascolarctos* elongated hollow outgrowths occur along the greater part of the posterior wall of the cavity, an extensive budding here taking place. The further development of these three muscles in the Marsupials agrees very closely with that of the same muscles in *Chelydra*. We cannot do more than give a general indication of the scope of the paper. Attention may be directed to the graphic plates drawn by E. A. Steele.

**Development of Heart in Marsupials.***—Katharine M. Parker has studied this in *Perameles obesula*, *P. nasuta*, *Dasyurus viverrinus*, and *Macropus ruficollis*. The early stages are like those in Eutheria. While the initiation of head-fold formation is in all probability due to the forward growth of the brain-plate, there occurs also an active backward growth of the anterior intestinal portal. This process is associated with the rapid extension of the pericardium which occurs at this period of development, and which brings about the backward and inward growth of the layer of splanchnopleure limiting the pericardium. In the course of this inward closure, the pericardial cavity extends to the ventro-lateral, and finally to the ventral side of the lateral primordia of the heart, so that when the lateral portions of the pericardium become incorporated in its median limb, the heart primordia lie in the dorsal wall of the pericardium.

The approximation of the heart-tubes after gut-closure is due to the fact that, at this period, the pericardium grows rapidly in length and decreases in width, so that the heart-tubes are brought together by longitudinal stretching of the pericardial wall lying between them. Curvature of the heart is due to its rapid growth at a period of less active extension of the pericardium.

The first two aortic arches in *Perameles* are typical, and the development of the veins of the head resembles that process in other mammals in that the anterior cardinal vein is derived from persistent portions of two primitive head-veins, the venæ capitis medialis and lateralis. The posterior continuation of the vena capitis medialis also contributes to the formation of the posterior cardinal vein, and is itself derived from the dorsal aorta.

**Placenta of Macacus.**†—Ed. Retterer describes the structure of the placental disks in *Macacus rhesus*. He finds that the fœtal portion of the placenta is due to the vegetative proliferation of the fœtal chorion, and that the maternal portion is due to the hypertrophy of the dermis of the uterine mucosa. The common character of these two tissues of different origin is the extensive retrogressive development which they

* Proc. Zool. Soc., 1915, pp. 459–99 (2 pls. and 25 figs.).
† C.R. Soc. Biol. Paris, lxxviii. (1915) pp. 323–7.

undergo. This leads to the opening of the maternal vessels, and to the interchorial or intervillous formation of lacunæ, or "sangui-maternal lakes."

**Egg-laying of Plethodon cinereus.***—W. H. Piersol describes the deposition of the eggs in this Canadian salamander. Fertilization is internal. The lips of the cloaca are pressed against the surface from which the eggs will eventually hang (e.g. in a decaying log), and a small quantity of mucus is extruded and adheres firmly to it. The extrusion of each egg occupies about twenty minutes, and an interval of five to ten minutes occurs before the next appears. Four to seven eggs were laid in contact. As is usual among Urodela the outer envelope of each egg is of a much more sticky mucus than the inner ones. In *Plethodon* the outer layer is unusually thin, and the deposition of the preliminary mass of very sticky mucus is peculiar. One egg of small size is often retained in the ovary and absorbed. If it is laid it develops normally. One female, kept in a terrarium, swallowed two of her eggs (in process of gastrulation), and regurgitated them three hours later—killed by the disturbance. Swallowing spawn has been noted for many Amphibia, usually when something has occurred to pervert the natural instincts. Smith describes it as normal for *Cryptobranchus*, and in this case the regurgitated eggs frequently continue to develop.

**Experimental Embryology.**†—G. Cotronei has begun a series of experiments on the developing eggs of frog and toad, which he has subjected to the influence of solutions of various strengths of sodium chloride, potassium chloride, magnesium chloride, lithium chloride, and lithium sulphate. The developmental modifications induced are only referred to in the present communication, which states the author's aim of tackling experimentally the important problem of the relation between correlation and differentiation.

### *b.* Histology.

**Identification of Tissues in Artificial Cultures.**‡—E. D. Congdon has inquired into the different kinds of tissues that are produced in artificial cultures. He has especially studied the origin of the common cell strings, reticula and membranes, and gives some very striking figures. A common type of reticulum with a corresponding membrane-growth can be traced back to sub-pericardial reticulum in a six-day ventricle. There is indirect evidence for a coarse reticular growth from the peritoneum of liver (five- and ten-day) and intestine (five- and ten-day), and from the endocardium and pericardium of ventricle (five- to fourteen-day). An unbroken sheet is found to arise from intestinal peritoneum under certain conditions.

Sectioned cultures of intestine (six-day) gave rise to a fine mesh similar to that of ventricle reticulum. Mesenchyme is sometimes given off from limb-buds (five- and ten-day) in the form of disorganized

* Trans. R. Canadian Inst., xxiv. (1915) pp. 121–6.
† Atti Rend. R. Accad. Lincei Roma, xxiv. (1915) pp. 1248–53.
‡ Anat. Record, ix. (1915) pp. 343–59 (5 pls.).

masses of cells. Under other conditions reticulum and a corresponding membrane-growth apparently also take their origin from limb-bud mesenchyme. In one sectioned five-day culture Congdon saw the contents of the wall of the atrial canal moving out into a strand of very coarse reticular growth, such as is common in cultures from four-day ventricle. Primitive myocardium of four- or five-day heart, therefore, apparently grows out as a coarse mesh, but it is unlikely that heart-muscle of the older ventricle has this power.

A growth of polyhedral cells resembling those from sub-pericardial reticulum was traced in sections to the endocardial cushion of the ventricle (thirteen-day). The scleretogenous tissue of a limb-bud can move out into the plasma for a short distance, but has little vitality (seven-day). There is an extension of the ectoderm of a limb-bud out into the plasma, but this is due, in part at least, to a creeping of the original layer, as is shown by its marked thinning on the surface of the limb-bud (five- and ten-day). The spindle-shaped pre-muscle cells of seven-day limb-buds give a characteristic linear growth in the plasma and upon the cover-slip.

**Nuclei of Auditory Cells in Rabbit.*** —E. Vasticar describes a peculiar nuclear structure in the external auditory cells and the cells of Deiters in the rabbit. He has observed a similar appearance in the internal auditory cells. In the external auditory cells there is a sort of rodlet implanted in the cephalic pole of the nucleus and inclined towards the axis of the cochlea. It is cylindrical, about a tenth of the diameter of the nucleus, and up to a sixth of its length. It is formed of an amorphous, opaque, non-granular substance, and its free end is in direct relation with the base of the endoplasmic cone which covers the greater part of the "cephalic hemisphere" of the nucleus.

In the cells of Deiters there is a similar rodlet in a similar position, but inclined away from the axis of the cochlea. Its free end is in direct relation with the basal portion of the granular portion of the cell of Deiters. In the cells of Deiters of the third row there is a nuclear structure different from that in the first two rows. It is cylindro-conical and larger. Its free end is in contact with the inferior part of the granular segment, which is strongly developed.

**Structure of Erythrocytes.†**—Charles D. Cupp has investigated the minute structure of the erythrocytes in the "blind eel" (*Amphiuma means*), which has the largest known red blood corpuscles), in the alligator, in a snake, and in Mammals (guinea-pig and man). His chief method was the study of sections. The erythrocyte is an extremely differentiated element, especially in Mammals. It normally possesses a framework in the form of a fine-threaded, somewhat elastic reticulum, in the meshes of which the hæmoglobin is supported so intimately that its content partakes of the physical characters of gelatin. In the nucleated forms this reticulum is continuous into the nucleus, supporting its structures. The corpuscle has a peripheral membrane or capsule into which the threads of the reticulum grade, and which is derived from and

* Comptes Rendus, clxi. (1915) pp. 58-60 (3 figs.).
† Anat. Record, ix. (1915) pp. 259-80 (4 figs.).

consists of a peripheral condensation or massing of the reticulum. There is a similar but thinner perinuclear condensation of the reticulum bounding the confines of the nucleus, and forming a nuclear membrane in the nucleated forms. The central nuclear knots of the mammalian red blood corpuscles represent remains of the nuclear membrane and reticulum originally existing in the central part, and result from or after the disturbance of the interior produced by disintegration or extrusion of the nucleus.

**Silvery Colour of Fishes.***—P. Murisier supports Popoff's view that the silvery sheen of open-water fishes is protective, since it harmonizes with the surface, which appears silvery when seen from a certain depth. The silveriness of the surface is due to the fact that the oblique rays of light which penetrate into the water undergo a double total reflection—the first from below upwards in meeting fine particles in suspension, the second from above downwards at the bounding surface between the water and the air. The silvery appearance of the ventral surface of fishes makes them invisible to carnivorous enemies looking up from below. Fishes of deep and dark waters tend to be sombre.

Murisier has experimented with lake-trout (*Trutta lacustris*), and finds that if these are reared for nine months in bright light on a white floor, the ventral surface and the sides are brilliantly silvery; while if they are reared in darkness, or on a dark-coloured floor, they are sombre and without silveriness. The melanophores normally form a screen absorbing the light-rays: if the screen is not developed, or is interrupted, then silveriness is produced. The non-development of the melanophores is due to a nervous influence operating through the eyes. Blind trout remain of a dull colour on a white ground. The adaptiveness of the silvery colour is thus very direct.

### c. General.

**Diseases of Fishes.**†—T. Southwell reports on a variety of diseases in Indian fishes. The subcutaneous intermuscular tissue of *Rasbora daniconius* (= *Cyprinus daniconius*) was found in four cases infected with Myxosporidia, probably of the genus *Myxobolus*, and closely allied to *Glugea bombycis*, which causes silkworm disease. In the skin of *Cirrhina lata* were found cysts with cercariæ, possibly the young of *Holostomum cuticola*; other cysts with cercariæ were found in the skin of *Nuria danrica* and in the superficial muscles of two other fishes. A carcinoma of the thyroid of the rainbow trout (*Salmo irideus*) is described. A new parasitic Isopod (*Rocinella latis* sp. n.) was found on *Lates calcarifer*, the Bhekti, *Argulus foliaceus* from the skin of *Labeo rohita*. From the cœlom of *Diagramma crassispinum* were obtained specimens of *Amphilina magna* sp. n. The transparent flesh of the "Bombay duck," *Harpodon nehereus*, contained cysts of the larvæ of

* Proc. Verb. Soc. Vaud. Sci. Nat. (1915) pp. 95–7, in Bull. Soc. Vaud., l. (1915).
† Records Indian Museum, xi. (1915) pp. 311–30 (3 pls.).

*Syndesmobothrium filicolle* Linton. This seems to be the first record of a cestode parasite occurring in the flesh of any fish east of Suez. The parasite becomes adult in the larger species of *Trygon* and *Hypolophus*; and there is not the slightest danger of man being infected.

**Faunistic Survey of Blacksod Bay.***—G. P. Farren has compiled an account of the fauna of Blacksod Bay, Co. Mayo. The algæ and lichens are also dealt with and the geological features. The fauna of the rocky shore is divided into four sets. (1) There are the animals exposed to the air on stones, rock faces, or weeds, e.g., species of *Littorina*, *Purpura lapillus*, *Patella vulgata*, *Actinia equina*, *Halichondria panicea*, *Sycon compressum*, *Phallusia mentula*, *Spirorbis borealis*, *Helcion pellucidum*. (2) There are animals found under stones, such as Amphipods, *Lineus ruber*, many Polychæts, many Molluscs. (3) There are animals living in the crevices of the rocks, chiefly Polychæts, Nemerteans and Gephyrea. (4) There are animals living in Laminarian roots, especially Turbellarians, Nemerteans and Polychæts. The fauna of the sandy beaches includes *Cylista undata* on *Cardium edule*, *Lineus acutifrons*, *Tubulanus linearis*, *Echinocardium* and *Synapta*, many Molluscs and Polychæts. The Zostera beds are marked by numerous Polychæts, such as *Nereis cultrifera*, *Scoloplos armiger*, *Cirratulus tentaculatus* and *Notomastus latericeus*. On or amongst the blades are found *Anemonia sulcata*, *Leucosolenia variabilis*, *Lacuna divaricata*, *Zippora membranacea*, *Hippolyte prideauxiana* and *H. varians*, the compound Ascidian *Aplidium zostericola* (?), and the fishes *Nerophis ophidion* and *Spinachia vulgaris*. The sub-littoral fauna is also dealt with. The total number of animal species recorded is 1005.

**Reactions of Fishes to Salts.**†—Morris M. Wells finds that fresh-water fishes recognize and react to the presence of salts in solution. The reaction is one that tends to bring them into their optimum salt solution. Fresh-water fishes (and probably marine fishes also) are not as sensitive to salt ions as they are to hydrogen or hydroxyl ions. The reactions to either the ions of salts or acids are complicated by the presence of the ions of the other. Fresh-water fishes react to combinations of antagonistic salts or to an antagonistic salt and acid in a way that tends to bring them into a region of optimum stimulation. The phenomena of antagonism are thus indicated by the behaviour as well as by the resistance of organisms.

Starvation causes certain fishes, e.g. the rock bass (*Ambloplites rupestris*), to select higher concentrations of salt than those normally selected. Other fishes, e.g. the bull-head (*Ameiurus melas*), when starved, select lower concentrations than normally. Over-feeding causes bull-heads to select higher concentrations than those normally chosen. Rock bass and bull-heads which are normally negative to calcium chloride solution (0·01 N), become positive after being kept in this concentration for about a week. They become negative again when returned to

* Sci. Invest. Fisheries Ireland, 1914, iii. (1915) pp. 1–72 (1 map).
† Journ. Exper. Zool., xix. (1915) pp. 243–18 (3 figs.).

tap-water for twenty-four hours. It is suggested that excess of calcium salts in contaminated water, e.g. near paper-mills, may account for the occurrence of tailless trout.

The author's observations are of great interest in connexion with the migrations of fishes. The migrations of anadromous fishes, like the salmon, are probably correlated with rhythmic changes in metabolism. These alterations in metabolic activity are largely the result of internal changes such as occur with the ripening of the sexual products.

The fresh water has a low specific gravity and is consistently acid in reaction; the sea water has a relatively high specific gravity and is consistently alkaline. In the fresh water the fishes are positive to currents, and, in a gradient, select water that is just on the acid side of neutrality and of lower density than that of the sea. Salt-water fishes, on the other hand, are probably negative to a fresh-water current, select water on the alkaline side of neutrality, and reject water of low specific gravity for that of higher. The reversal in reaction must occur at least twice in fishes like the salmon.

Fishes react to environmental factors long before the adjustment becomes a matter of life and death. Day has shown that the salmon might remain in fresh water without results fatal either to the individual or to the species. "The mechanism, therefore, which is working to preserve the life of the organism is so delicate that it produces beneficial reactions upon the part of the animal far in advance of life and death complications. The working of this mechanism is undoubtedly closely connected with quantitative and perhaps qualitative changes in metabolism. These changes in metabolism will have a direct relation to the amount of $CO_2$ given off by the organism."

A slight increase in the carbon dioxide content of an animal's blood results in a marked increase of general irritability, which will result in an increase in the range and vigour of the movements. The state of metabolism in the sex organs probably furnishes the initial stimulus to breeding migration. The instinct which causes the salmon to leave fresh water for the sea is backed by some very strong stimulus, as is shown by the persistent way in which they will leap from ponds. Yet they are reacting in a way that is not immediately essential.

**Physiology of Migration of Mullets.*** — Louis Roule has made interesting observations on the movements of Grey Mullets (*Mugil*) from littoral ponds and estuaries to the sea. The currents of water from the sea towards the ponds are richer in dissolved oxygen than the currents in the opposite direction. The metabolism consequent on the development of the large gonads involves, as in the salmon, an intensification of respiration. The mullets therefore make for the water with greater oxygen-content. Roule has previously shown † that the movements of the salmon are also affected by the variable oxygenation of the water at the mouths of rivers. Other factors operate, of course, in the migration of fishes, notably those connected with depth, temperature, and salinity.

* Comptes Rendus, clxi. (1915) pp. 537–9.
† Comptes Rendus, clviii. (1914) p. 1364.

**Movements of Amphioxus.***—Leslie B. Arey has studied the movements of *Branchiostoma caribbæum* Sundevall, common at Bermuda. It can swim backward for short distances, but its normal orientation in continued swimming is with the anterior end in advance. When a somersault brings it tail-end in advance, another reversal follows directly, or else the animal changes its course and returns more or less in the direction from which it came. It burrows in the sand tail foremost.

During locomotion the head and tail are bent simultaneously toward the same side: the posterior of all the flexures, which is by far the most prominent, occurs approximately at the level of the atriopore; the next prominent flexure is at about the region of the first gonads, but is much less extensive than the former. When the animal is swimming slowly no other flexures are evident, except a suggestion of one rather close behind the anterior flexure last described. The occurrence of the two largest flexures just anterior and posterior to the gonad-pouches suggests that these pouches materially increase the rigidity of the body throughout the region where they occur, and thus actually determine the position of the major flexures. As might be expected, when a forward spring occurs the first flexure is initiated at the anterior end, and muscular activity extends posteriorly like a wave; when the animal leaps backward the reverse is true. When the swimming response is nearing completion, the rate of the muscular movements rapidly decreases, and ends in complete collapse. After cessation of movement, the animal is carried for a short distance by its own momentum and then sinks slowly to the bottom.

## INVERTEBRATA.

### Mollusca.

**South African Marine Molluscs.†**—Paul Bartsch reports on a large collection of Molluscs made by Lieut.-Colonel W. H. Turton at Port Alfred, and on others in the United States National Museum from the South African faunal area. Numerous new species are described. Attention is drawn to the prevalence of red coloration in Turton's collection, which seems to be explained by the fact that the red algæ form the dominant element in the marine vegetation of the region.

### Arthropoda.

#### a. Insecta.

**New England Sarcophagidæ.‡**—Ralph R. Parker describes the external structure of the males of the genera *Ravinia* and *Bœttcheria* g.n. A detailed account is given of the parts of head, thorax, and abdomen; the "vestiture" of these parts, i.e. the covering, exclusive of bristles or

* Journ. Exper. Zool., xix. (1915) pp. 37–44.
† Smithsonian Inst. U.S. Nat. Museum, Bull. 91 (1915) pp. 1–305 (53 pls.).
‡ Proc. Boston Soc., xxxv. (1914, received 1915) pp. 1–77 (8 pls.).

macrochætæ; the chætotaxy, or arrangement of bristles; and the genital apparatus. The taxonomic value of the different characters is discussed, and the genera mentioned are contrasted with *Sarcophaga*, the third genus in the family.

**New Genus of Blepharocerid Flies.***—F. W. Edwards establishes the new genus *Elporia*, to receive what he previously described as *Kelloggina barnardi*. The new genus differs from *Kelloggina* in having divided (dichoptic) eyes, and from *Paltostoma* in the longer male palpi, the absence of mandibles in the females as well as the males, the shorter proboscis, the divided eyes, the structure of the last tarsal joint, and details of the spines, respiratory filaments, and anal papillæ of the larvæ. The author describes *Elporia capensis* sp. n., which differs markedly from *E. barnardi* in all its stages. The respiratory tufts and the larval spines seem to be of considerable systematic importance.

**Inheritance of Bristles in Drosophila** †—Edwin Carleton MacDowell has studied the inheritance of extra bristles on the thorax of *Drosophila ampelophila*. There are normally four bristles forming a rectangle on the dorsal surface of the thorax. The extra ones occur in the two longitudinal rows of the normal bristles, or just medially or laterally to these rows. From a pair of wild flies a race was established which had regularly more than the normal four. By selecting high-grade parents and inbreeding brother to sister the number of bristles was gradually increased (up to nine extras) for six generations. From the seventh to the eleventh generations fluctuations were found showing no further increase. The maintenance of the high grades of extra bristles does not depend upon selection, for low-grade parents from mass cultures started from the fifth and sixth generations that have run eight months give, when raised as single pairs, as high-grade offspring as inbred and selected parents mated at the same time.

A Mendelian factor is involved in the inheritance of extra bristles, and as normal dominates extra, this may be regarded as a dominant factor that restricts the number of bristles to four. This factor is not sex-linked, although the males are apt to have fewer bristles.

The extracted extra-bristled flies have a lower distribution than that of the inbred flies of the corresponding generation, although the high extremes of the inbred race are also found among the extracted extras. There is a greater difference between the inbred and extracted distributions when the cross is made after eight selections than when made after only one selection Environment influences the number of extra bristles, and the amount of food is very important.

The author adopts the hypothesis that the extra bristles are due to the absence of one main restricting factor, and their number is also influenced by accessory restricting factors, which, in the absence of the main one, produce flies with reduced numbers of extra bristles.

* Ann. Nat. Hist., xvi. (1915) pp. 203–15 (22 figs.).
† Journ. Exper. Zool., xix. (1915) pp. 61–98 (6 figs.).

**Larva and Pupa of Caligo memnon.***—F. L. Davis gives an account of his observations on the development of *Caligo memnon* at Belize, British Honduras. The larvæ avoided sunlight and crawled from a distance about sundown to their food-plant, the banana. In the position for pupation they hang head downwards, with only the anal extremity attached to a small web. The colours of the larvæ are carefully described. Springing from the central dorsal black line are what appear to be very sharp and pointed black spines standing vertically upwards. But though they look formidable, they are quite soft and easily bent. Eight "horns" surround the edge of the head.

**Protective Value of Mimetic Resemblance.**†—E. Rabaud has studied the case of the larvæ of *Rhogas*, a hymenopterous parasite on lepidopterous caterpillars, in regard to the supposed protective resemblance of the caterpillar skin to a Campopleg cocoon. The larvæ of *Rhogas* pupates within the body of its host, which by that time is a mere dry and empty skin. The anterior part of the skin usually withers and shrinks, while the posterior part inhabited by the larvæ keeps its caterpillar shape. The author examined numbers of *Pieris brassicæ* caterpillars infested by the parasite, and came to the conclusion that the resemblance was quite fortuitous. For every skin that looked deceptively like the Campopleg cocoon, there were many others that looked quite different, though some of them showed a very imperfect resemblance. The degree of resemblance depended in part on the extent to which the anterior portion of the caterpillar's body was eaten away, and on various external circumstances. From the persistence of the very numerous imperfect forms the author argues that mimetic aspect has no protective value.

**Scent-organs in Male Danaine Butterflies.**‡—H. Eltringham has previously described the scent-glands and brushes in *Amauris niavius* Linn. Each gland consisted of several cells communicating on the upper surface of the wing with a projection which the author called a "scent-cup." This bore a cover pierced by a median pore. Tufts of setæ in an eversible sac form two brushes at the hinder end of the abdomen, and part of the brush-bag contained cells which produced delicate threads that break up into dust. The butterflies apply their brushes to the glandular patches on the hind-wings, and the dust may assist in the diffusion of the scent.

Eltringham proceeds to describe corresponding structures in other species. Neither wing-glands nor dust-producing devices are invariably present; the brush itself, and not the wing, may produce the scent material, or at least exhibit a glandular structure, whilst the dust may be produced by the wing and not by the brush, and in the pupal instead of in the imaginal state. An account is given of the state of affairs in five species of *Amauris*, two species of *Danaida*, and some other butterflies. There is no direct evidence that a scent is produced, but the argument from analogy is strong.

* Trans. Entomol. Soc. London, pt. 2 (1915) pp. 198–200 (1 pl.).
† Bull. Soc. Zool. France, xl. (1915) pp. 56–63 (1 fig.).
‡ Trans. Entomol. Soc. London, 1915, pp. 152–76 (10 pls.).

Perhaps the most remarkable feature of the intricate organs described is the elaborate development of friable setæ producing quantities of dust. Fritz Müller described such hairs in the wing-folds of Hesperidæ and called them "chain-bristles," since they took the form of long hairs constricted at regular intervals, and liable to break at each constriction. The yellow "fluff" on the hind-wing of the male moth *Erebus macrops* consists mainly of "chain-bristles" of an exceedingly beautiful form.

**Life-history of Aleochara bilineata.***—J. T. Wadsworth describes the life-history of *Aleochara bilineata* Gyll., a Staphylinid parasite of *Chortophila brassicæ*, the common cabbage-root fly. The ova of *A. bilineata* are deposited in the soil, probably near the roots of cabbages, etc., which are attacked by *C. brassicæ*. The larvæ emerge in about ten days, and are typical, free-living, campodeiform, Staphylinid larvæ. They enter the puparia of the cabbage-fly, feed on the pupæ, and at the first ecdysis emerge as eruciform larvæ. They thus undergo a simple form of hypermetamorphosis as a result of their parasitic mode of life. Three ecdyses occur during larval life. It was previously believed that the ova or larvæ of the beetle entered the fly-larvæ, but this has been shown to be erroneous. After the first ecdysis the larvæ feed rapidly; pupation takes place within the puparium of the host, and the adult beetle gnaws a hole in it and emerges. Detailed descriptions of the ova, larva, pupa and imago are given. Two generations of the Staphylinid are produced in the district investigated (Manchester), and it is suggested that in warmer areas three or more may be produced in a year. Adults of the first generation are produced in May or June, having entered the puparium of their host as larvæ the previous autumn. Adults of the second generation emerge in August and September, having completed their development in six or seven weeks. The rate of development of winter larvæ may be greatly hastened by placing them in warm surroundings. The percentage of puparia of the cabbage-fly found to be infested with *A. bilineata* ranged from 10 to 26 p.c., according to the season. The investigator estimates that about 20 p.c. of the larvæ and pupæ of *C. brassicæ* are destroyed by coleopterous and hymenopterous parasites in the district where he obtained his material, and he suggests that in view of the destructiveness of the fly the utilization of its natural enemies is worthy of consideration.

### δ. Arachnida.

**Variability in Size of Amblyomma.**†—L. E. Robinson discusses the variability in the size of the male of a South African tick, *Amblyomma hebræum*. In one set of eighty the length of the scutum ranged from 5·7–4·2 mm.; the breadth from 4·9–3·5 mm.; while the mean breadth to length ratio was 0·85 approximately. In another set of sixty, the length of the scutum ranged between 5·4 and 3·5; the maximum and

* Journ. Econ. Biol., x. (1915) pp. 1–26 (2 pls. and 1 fig.).
† Parasitology, viii. (1915) pp. 11–16 (3 figs.).

minimum breadths were 4·7 mm. and 3·2 mm. respectively; the mean breadth to length ratio had risen to 0·87. As Aragão and Nuttall have pointed out, the variability depends on the nutritive conditions.

**New Guinea Spiders.***—H. R. Hogg reports on a large collection of spiders from Dutch New Guinea. There are twenty-seven genera and forty-three species or sub-species. About eighteen appear to be new. A new genus *Exopalystes* is established, intermediate between the groups Deleneæ and Heteropodeæ, but near *Palystes*. As might be expected from a district so well supplied with insect-life, the local representatives of the various genera are particularly powerful and well developed, producing in closely allied species such differences as a superabundance of mandibular teeth in groups like the Deleneæ, where the number has been generally considered a matter of more than specific importance.

**Antarctic Pycnogonids.†**—W. T. Calman reports on the Pycnogonida collected by the British Antarctic ('Terra Nova') Expedition. The collection far exceeds in extent that of any Antarctic Expedition yet reported on. It comprises no fewer than forty-four species, all from the Ross Sea area, with the exception of a specimen of *Colossendeis megalonyx* Hoek, dredged near the Falkland Islands. Eleven species are described as new, while five others are identified with species only very recently described in Hodgson's preliminary report on the Pycnogonids of the German South Polar Expedition. The Antarctic seas are far richer in species of Pycnogonida than any similar area of the oceans. As to numbers of individuals, it is noted that 200 specimens of *Nymphon australe* were obtained at a single station, and presumably at a single haul, but most of the species were obtained in very small numbers.

Carpenter has expressed the view that Pycnogonida show great plasticity, but Calman doubts that they show more variation than many groups of Crustaceans do. Döderlein has attributed great importance, among the factors favouring the development of local races, varieties, and species in any group of animals, to the lack of "Vagilität" or power of wandering, and there are few groups of Arthropods that show less of this power than the Pycnogonida. Although some species have the power of swimming in the adult state, their efforts seem to be awkward and inefficient, and none of the larvæ are better adapted for locomotion. Of all Pycnogonida hardly any can be less "vagile," as adults or as larvæ, than the species of *Pycnogonum*; yet not only *P. gaini*, but also the common *P. littorale*, show that a species may have a wide range and great constancy of specific characters.

Calman discusses the significance of decapodous Pycnogons which, with Carpenter, he holds to be a recent specialization, not a primitive survival. Bouvier's criticism of this interpretation is considered, but Calman adheres to his position. Reference is made to an interesting

* Trans. Zool. Soc. London, 1915, pp. 425–84 (18 figs.).

† Brit. Antarctic ('Terra Nova') Exped., 1910 (Zool.) iii. No. 1 (1915) pp. 1–74 22 figs.).

parallel in Selachians, where a *Pliotrema*, a Pristiophorid shark described by C. Tate Regan, has six branchial arches instead of the usual five, but is evidently a very highly specialized form, derivable from some ancestor like *Pristiophorus*, with the normal number of arches.

### ε. Crustacea.

**Habits of Atya, Caridina and Myctiris.***—R. P. Cowles has studied the feeding habits of *Atya mollucensis* and some species of *Caridina* from streams in the Philippines. In both genera the chelæ of the first and second legs are peculiarly shaped and are provided with dense groups of setæ like a camel's hair-brush. A microscopic examination of the setæ shows that each has finer setæ growing from it. Observations on *Atya* show that brushes spread out to make wide open, almost funnel-shaped strainers, the larger open ends of which are directed towards the stream. They collect small organisms and particles in the water. Each chela has two brushes or strainers, making eight in all. When a pair of strainers has collected enough, the setæ become grouped into a single brush, the chela turns backward on its base through almost 180°, and the brush is applied to the mouth where the food is extracted. The last part of the operation takes less than half a second, and then the chela returns to its former position.

In *Caridina* the chelæ have a different form, and the setæ are shorter and less numerous. They do not seem to spread out to form a strainer. The animals are mud-feeders; they sweep the surface with their brushes, and apply these to their mouth.

Specimens of *Myctiris longicarpus* Latreille move about in armies on exposed sand flats at low tide. The grey-blue, almost spherical, body is of about the size of a large cherry. All the individuals move in the same general direction. They are continually scooping up sand with their chelipeds and smearing it over the mouth parts, probably feeding on minute organisms and on detritus. When alarmed they sink into the sand with astonishing rapidity—about two or three seconds. Each digs with the legs of one side and rotates at the same time, so that the digging follows a spiral.

**Fresh-water Crab from Australia and New Zealand.**†—Charles Chilton describes a small fresh-water crab, *Hymenosoma lacustris* Chilton (= *Elamena* (?) *lacustris* Chilton), which is known from three localities in the north of New Zealand, from Norfolk Island, Lord Howe Island, and from two localities in Victoria, Australia. It is a true fresh-water species widely distributed in localities now separated by broad tracts of ocean. Judging from its distribution, Chilton regards the species as of very considerable antiquity. In one specimen from Lake Takapuna, Auckland, there were about twenty zoëæ lying free under the abdomen.

* Philippine Journ. Sci., x. (1915) pp. 11–16 (3 pls. and 2 figs.).
† Trans. New Zealand Inst., xlvii. (1915) pp. 316–20 (1 fig.).

**New Zealand Species of Elasmopus.***—Charles Chilton discusses the New Zealand species of this genus of Amphipoda Gammaridea, viz. *E. subcarinatus* Haswell, *E. neglectus* sp. n., and *E. bollonsi* sp. n. The genus appears to be closely allied to *Maera*, and *M. viridis* Haswell, which Stebbing placed under *Elasmopus*, is best left under *Maera*. The species *E. subcarinatus* and those allied to it appear to be distinguishable from *Maera* by the small accessory flagellum, by the robustness of the peræopods, and by the third uropod not reaching far beyond the others.

**Variability of Oral Appendages of Terrestrial Isopods.**†—W. E. Collinge has enquired into the range of variation in the oral appendages of *Ligia oceanica*, *Trichoniscus roseus*, *Oniscus asellus*, *Porcellio scaber*, *P. lævis*, *Porcellionides pruinosus*, and *Armadillidium vulgare*, and has examined 438 specimens. Of these no fewer than 110 exhibited variations. Thirty-one variations occurred in the form of the mandibles, twenty-eight in that of the first maxillæ, twenty-one in that of the second maxillæ, and thirty in the form of the maxillipedes. The oral appendages are evidently subject to a considerable amount of variation, and for purposes of specific distinction are not of the value generally supposed, and are certainly not so constant as the form of the head, the mesosomatic segments, the antennæ, the telson, the uropods, and the thoracic appendages.

**Number of Chromosomes in Male Daphnia.**‡—Monica Taylor has enquired into the number of chromosomes in different tissues of the male *Daphnia pulex*, and also in the various generations of cells in the testis. The number of chromosomes in the spermatogonial cells is the same as in the tissue-cells of the female, and lies between eight and ten. In somatic mitosis the diploid number (eight or ten) is also to be seen.

Spermatogenesis in *D. pulex* is perfectly typical. The spermatogonial cells contain the diploid number of chromosomes; reduction ensues; two meiotic divisions follow; the first and second spermatocytes contain the haploid number (some have five, others four). The eggs which develop into males must contain the diploid number of chromosomes, in which respect they resemble those summer eggs which have developed parthenogenetically into females.

## Incertæ Sedis.

**Polyzoa of 'Siboga' Expedition.**§—S. F. Harmer gives an account of the Entoprocta (*Loxocalyx*, *Loxosoma*, *Pedicellina*, and *Barentsia*), and of the Ectoproctous sub-order Ctenostomata and Cyclostomata. Some have thought that Polyzoa do not flourish in tropical conditions, but it is plain that in Malay waters, at least, they are present in large

* Trans. New Zealand Inst., xlvii. (1915) pp. 320–30 (12 figs.).
† Journ. Linn. Soc. (Zool.) xxxii. (1914) pp. 287–93 (2 pls.).
‡ Zool. Anzeig., xlv. (1914) pp. 21–4. (Privately reprinted.)
§ 'Siboga' Expeditie, Monographie xxviii.*d* (1915) pp. 1–180 (12 pls.).

numbers, both of species and of individuals, and that they occur from the littoral region down to the greatest depths investigated. The 'Siboga' collection is by far the richest that has at present been made in any tropical region. Twenty-five new species are established, twelve in the genus *Loxosoma*. The others belong to the genera *Loxocalyx*, *Pedicellina*, *Barentsia*, *Victorella*, *Arachnidium*, *Arachnoidea*, *Nolella*, *Mimosella*, *Buskia*, *Reptotubigera*, *Tubulipora*, *Tervia*, *Supercytis*, and *Lichenopora*.

**Polyzoa of Chilka Lake.***—Nelson Annandale reports on three species—*Loxosomatoides lævis*, *Membranipora hippopus*, and *Alcyonidium mytili*—found in Chilka Lake. Five other species are known from brackish water on the coasts of India. The species *L. lævis* and *L. colonialis* (from the Ganges) have been found only in water of slight or variable salinity. The others occur also in the sea. The author finds that *Loxosomatoides* (which is closely related to the North American fresh-water genus *Urnatella*) produces resting-buds, and the structure of these is discussed.

## Annulata.

**Australian Polychæts.†**—W. B. Benham reports on a collection of Polychæta made by the 'Endeavour' on the coasts of New South Wales, Victoria, Tasmania, and South Australia. Of the twelve new species collected by the 'Challenger' four were found again by the 'Endeavour,' namely, *Stauronereis* (*Staurocephalus*) *australiensis*, *Polynoe platycirrus*, *Eunice pycnobranchiata*, and *E. bassensis*. The last was founded for a small fragment; it is now described fully. Eleven new species have been established, e.g. one of each of the interesting and rare Lumbriconereid genera, *Œnone* and *Lysarete*. Perhaps the most interesting feature of the collection is the abundance of the Polynoid genus *Physalidonotus*, originally discovered in New Zealand, and later on in Japan. Four new species are described. The genus is probably widely represented through the Pacific Ocean.

**Studies on Terebellids.‡**—M. Caullery discusses a number of Terebellidæ which he refers to a new tribe Thelepinæ. The branchial filaments are not ramified; the number of segments with bundles of capillary setæ is variable and usually large; the tori of uncini form one series; and the uncini have a button at the base of the manubrium. He finds that four well-established genera may be referred to the Thelepinæ, namely, *Thelepus* Leuck, *Streblosoma* Malmg., *Euthelepus* Malmg., and *Parathelepus* n. nom. (= *Thelepides* Southern). Caullery describes *Streblosoma longiremis* sp. n. from the 'Siboga' collection, characterized by large anterior setigerous appendages, very long and fine setæ, and cochleiform tubes which recall the shells of *Turrilites* among Ammonites. The wall of the tube is composed of an encrustation of Foraminifera and a very coherent paste. The interior is lined by a

* Mem. Indian Museum, v. (1915) pp. 121–33 (3 figs.).
† Biol Results Fishing Experiments, Australia, iii. (1915) pp. 173–235 (8 pls.).
‡ Bull. Soc. Zool. France, xl. (1915) pp. 44–53 (2 figs.).

delicate, glistening, translucent secretion. Some of the unfinished tubes are like those of *Spirorbis*, and spiral tubes have been recorded for *Streblosoma cochleatum* Sars and a few other related forms.

**Echiuroids of Chilka Lake and of the Gangetic Delta.***—N. Annandale and Stanley Kemp describe *Thalassema dendrorhynchus* sp. n. from Chilka Lake and *T. branchiorhynchus* sp. n. from the Gangetic delta. The first is closely related to *T. sabinum* from Talé Sap, a lagoon in Lower Siam. The three live in peculiarly dense mud and belong to a group typified by *T. neptuni* Gaertner (the type species of the genus); they are characterized by the comparatively simple nature of the anal trees, by the possession of two pairs of nephridia, and by the undivided sheath of longitudinal muscles. The structure of the proboscis in the three species is peculiar, and this is perhaps associated with their habitat. The excavations are made not by the proboscis only, but by body and proboscis; and the proboscis has probably a respiratory as well as a muscular and nutritive function, for the dendritic outgrowths of its margin or ventral surface are gill-like, and are so situated that all the water which enters the mouth must first pass over them.

**New Earthworms.**†—Frank Smith and Elizabeth M. Gittins give a description of *Helodrilus* (*Bimastus*) *zeteki* sp. n. and *H.* (*Bimastus*) *longicinctus* sp. n., both from Illinois, and discuss the affinities of the two species. Frank Smith ‡ describes new varieties of *Helodrilus* (*Bimastus*) *gieseleri* and *Diplocardia singularis*, and gives a useful diagnostic key of the described species of Lumbricidæ from Illinois, excepting two species of *Pheretima*. The most abundant species of earthworm in long-settled parts of the United States is *Helodrilus caliginosus trapezoides*; in the prairie soil of Central Illinois *Diplocardia communis* (with a double dorsal blood-vessel) is very common; another common form in cultivated regions is *Octolasium lacteum*; and the European *Lumbricus terrestris* occurs locally, probably by introduction.

**New Marine Leech.**§—W. Harold Leigh-Sharpe describes *Ganymedebdella cratere* g. et sp. n., one of the Ichthyobdellidæ, which was taken near St. Margaret's Hope towards the north-east of S. Ronaldsay in the Orkney Islands. It was taken from a fish which was probably an immature male specimen of *Callionymus lyra*, the dragonet. The generic characters are stated as follows:—A leech divided in a very marked manner into a short neck and a very flattened abdomen. Each "complete" segment of the abdomen consists of six annuli, but only the first six are so divided. Along the side of the abdomen are three pairs of respiratory vesicles. There are two cæca. There are no seminal vesicles. There are no blackish-brown star-shaped pigment cells. There is no special development of the reproductive system.

As to specific characters, the author notes that the anterior sucker is

* Mem. Indian Museum, v. (1915) pp. 57–63 (3 figs.).
† Bull. Illinois State Lab. Nat. Hist., x. (1915) pp. 545–50.
‡ Bull. Illinois State Lab. Nat. Hist., x. (1915) pp. 551–9 (1 pl.).
§ Parasitology, iii. (1915) pp. 1–10 (6 figs.).

over four times the size of the posterior sucker. It has a muscular rim and five muscular bands. The last segment of the anal region bears ventrally a sensory papilla. There are no eyes. A detailed comparison is made between *Calliobdella lophii* and this new form. Certain characters are believed by the author to indicate that *Ganymedebdella cratere* is a stationary parasite. These are (1) its peculiar attachment to the anal papilla of its host by means of an enormously developed anterior sucker; (2) the weak development of the longitudinal muscle layer; (3) the shallowness of the posterior sucker: and (4) the rarity of the leech.

### Nematohelminthes.

**Effects of Carbon Dioxide on Eggs of Ascaris.***—Theophilus S. Painter exposed eggs of *Ascaris megalocephala* to carbon dioxide for three months (July 14 to October 9) and afterwards allowed them to develop. Some of the embryos were perfectly normal; others had only one end of the body developed; others were totally disorganized. The author shows how the half-embryos and disorganized embryos arise. As to the question why some eggs are affected by the $CO_2$ treatment while others develop normally, it is pointed out all the eggs were taken from the fresh uterus of a single female, and that those from the end are further advanced than those from the tip. As to the question how the eggs were able to live and develop to a slight degree in an atmosphere of $CO_2$, the author adopts Weinland's view that glycogen in the egg is broken up into valeric acid, $CO_2$, and oxygen. Painter also records some observations bearing on the problems of sex-determination and of cell-diminution.

**Fresh-water Nematodes of Michigan.**†—Margaret V. Cobb and N. A. Cobb give an account of some fresh-water Nematodes of the Douglas Lake region of Michigan, and furnish a very useful key to the genera. Descriptions are given of *Tylencholaimellus diplodorus* g. et sp. n. and new species of *Actinolaimus*, *Dorylaimus*, *Ironus*, *Mononchus*, *Cyatholaimus*, *Chromadora*, *Ethmolaimus*, *Aphanolaimus*, and *Prismatolaimus*.

**Species of Rictularia.**‡—L. G. Seurat describes some of these Nematodes from the intestine of various carnivores from North Africa (jackal, fox, genet, and mongoose). He deals with *Rictularia affinis* Jägersk, *R. macdonaldi* (Dobson), previously reported from bats, and *R. proni* sp. n.—the last being marked by the small number of combs and needles, which are restricted to the anterior region; the position of the post-cervical papillæ very far forward; the shortness of the gullet and the ovijector; and the structure of the vulva. Some authors place *Rictularia* among the Strongylidæ, but Seurat maintains that the affinities of the genus (as marked in the structure of the gullet, the

* Journ. Exper. Zoology, xix. (1915) pp. 355-85 (3 pls. and 15 figs.).
† Trans. Amer. Micr. Soc., xxxiv. (1915) pp. 21-47.
‡ C.R. Soc. Biol. Paris, lxxviii. (1915) pp. 318-22 (3 figs.).

position of the post-cervical papillæ, the position of the excretory pore, the structure of the ovijector, the shape of the ova, the disposition of the genital papillæ) is with the Acuardiæ, near *Physaloptera*.

**Nematodes from Gill-chambers of Land-crabs.*** — H. A. Baylis describes two minute Nematodes — *Monhystera wilsoni* sp. n. (from *Gecarcinus ruricola*) and *M. carcinicola* (from the same crab and from *Cardisoma guanhumi*). The worms belong to a genus the species of which are commonly found free in earth or in fresh-water. Both the forms, as found in the crabs, appear to be either hermaphrodite or parthenogenetic, and at first sight seem to be all females. They are evidently not specially adapted for a "parasitic" mode of life, inasmuch as the number of young produced by one female is comparatively small, and these young are apparently hatched from the egg before birth.

**Worm Nodules in Australian Cattle.†** — J. F. McEachran and Gerald F. Hill have studied the occurrence of *Onchocerca gibsoni* in the northern territory of Australia. Local cattle may become infected a few months after birth. Well-developed nodules may be found in calves. Cattle from Victoria, where worm nodules are rarely, if ever, present, may become infected within six months if they graze with infected cattle. Some housed calves to which biting and flying insects had ready access, and which were not far removed from infected cows, were not affected during seven to eight months' exposure. This suggests that the intermediary host is not a biting or flying insect. Ordinary skin parasites which do not travel far, e.g. the buffalo louse, *Hæmatopinus tuberculatus*, may also be excluded. The pens of the calves were floored with concrete, and the calves had no chance of lying on or near the ground where infected cows had previously lain. This is taken to indicate that part of the life-history of the parasite (in an intermediary host) is spent on the ground. The authors cannot accept the suggestion of Cleland that *Stomoxys calcitrans* and *Culicelsa vigilax* act as intermediary hosts.

**Onchocerciasis outside Australia.‡** — Georgina Sweet has investigated the occurrence of species of *Onchocerca* and allied worms in cattle and related animals in many countries. A new species, *O. indica*, is described from Indian cattle. It overlaps in some respects *O. gibsoni* and *O. gutturosa*, but differs in the association in the male worm of a certain range of length of the larger spicule, intermediate between those two species, with a greater number of differently arranged anal papillæ than is found in either of them. It differs from *O. gibsoni* further in the thicker head of the male, the thinner head and tail of the female, and the generally longer œsophagus in both.

The limitations of these species appear to be geographical rather than otherwise, thus *O. gutturosa* is characteristic of Northern Africa, presumably in *Bos taurus*: *O. indica* is found in *B. indicus* in the

* Ann. Mag. Nat. Hist., xvi. (1915) pp. 414–21 (5 figs.).

† Published by the Commonwealth of Australia. 8 pp., no date (received October, 1915).

‡ Published by the Commonwealth of Australia. 53 pp. (12 figs), no date (received October, 1915).

peninsula of India; and *O. gibsoni* in *B. indicus* in the Malay peninsula, and as a very variable form in *B. taurus* in Australia and most probably the Malay Archipelago. The original parasite and its original host are probably to be sought for in the Indo-Malayan gaur (*B. gaurus*) or wild ox, or its closely allied species the bantin (*B. banteng*), from which also *O. gutturosa* may be derived indirectly through *O. indica*.

**Life-history of Nematodirus filicollis.***—C. L. Boulenger has studied the life-history of this common parasite of the duodenum of sheep, especially of lambs and yearlings. The eggs when laid contain an embryo with seven or eight cells. They pass out of the host with the fæces. Even under favourable conditions development takes place slowly, and the embryos are not ready to hatch until twenty-four to twenty-eight days have elapsed. In their early stages the embryos are not able to withstand desiccation and are killed if frozen or subjected to high temperatures.

While still within the egg-shell the embryo undergoes two ecdyses, and when ready to hatch is enclosed in a tightly fitting sheath formed by the incompletely cast skin of the second moult. The larvæ on liberation from the egg-shell are therefore in a more advanced condition than those of most other Strongyliids (e.g. *Hæmonchus* or *Anchylostoma*), and are in a stage comparable to that reached by the latter at the end of their period of free existence. The sheathed larvæ are often retained for a long time within the egg-shells, and both in this position and after hatching can resist complete desiccation for considerable periods, twenty months or even longer. When dried they are able to withstand freezing as well as temperatures much above those likely to be met with in the open.

The free larvæ will live for a considerable time in water; they possess well-developed migratory instincts and climb vertical surfaces, such as grass stems and blades, and the glass walls of vessels in which they are kept. The sheaths are cast off by the larvæ when these are subjected to temperatures approximating to the blood-temperature of the host; completion of the second moult occasionally also occurs at laboratory temperatures under certain abnormal conditions. No infection experiments were made on sheep, but other evidence shows that these animals are infected by swallowing the sheathed larvæ, either when free or whilst still enclosed in the egg-shells. A number of young stages of the parasite were met with in the intestines of sheep, the smallest of these being only a little more advanced in structure than the larvæ just after ecdysis.

## Platyhelminthes.

**Avian Cestodes.**†—Frank E. Beddard gives an account of the structure of *Chapmania tauricollis*, from the right cæcum of a *Rhea*, describing in particular the genital organs. He discusses the members of the sub-family Idiogeninæ, marked by the presence of a single paruterine

* Parasitology, viii. (1915) pp. 133–54 (2 pls. and 5 figs.).
† Proc. Zool. Soc., 1915, pp. 429–43 (6 figs.).

organ in the ripe proglottid, and defines the genera *Sphyronchotænia*, *Otiditænia*, *Chapmania*, and *Idiogenes*. In the first there are ten to twelve rows of hooks on the rostellum; in the others there are two rows. We note the definition of *Chapmania*:—Suckers armed; genital pores alternate; longitudinal muscles thick; dorsal water-vascular vessel absent in posterior proglottid: testes numerous, posterior; uterus divided into chambers, which in the mature uterus communicate to form a network, larger than the paruterine organs; the eggs are transferred early to the paruterine organ: cirrus-sac large.

**Fish Trematodes of North Queensland.***—W. Nicoll describes a number of new Trematodes from North Queensland fishes. Trematodes were found only in 21 p.c. of the fishes examined, but more than half of the species described represent new generic types differing considerably from those occurring in other parts of the world. The new genera are:—*Maculifer*, with affinity with Allocreadiidæ; *Coitocæcum*, with resemblance to Allocreadiidæ, but differing in the absence of cirrus-pouch and the condition of the intestinal diverticula: *Nephnidiogenes*; *Xenopera*, in some ways like a Hemiurid; *Opistholebes*; and *Gyliauchen*, one of the Paramphistomidæ.

**Trematodes of British Marine Fishes.**†—W. Nicoll has done a useful piece of work in compiling a list of the Trematodes found in British Marine Fishes. Many of the records are due to his own investigations. The list includes no fewer than 241 parasites in 86 hosts. The whiting stands pre-eminent for the number of its parasites, but this is partly because it has been examined so often. The grey gurnard and the red gurnard, the common dab, the plaice, and the long rough dab are much infected. There are gaps in the records for angler, bullhead, turbot, smelt, and rockling.

**Life-history of Bilharzia.**‡—R. T. Leiper reports on his mission to Egypt to investigate Bilharziosis. The lesions are mainly due to the damage caused by the hard-shelled eggs of the parasite acting as foreign bodies in the tissues. The theory of Looss (1894) that the disease is communicable directly from man to man has influenced the research of the last twenty years.

The absence of a definite pharnyx in the cercaria is the one reliable character by which a Bilharzia cercaria can be distinguished from the cercariæ of other Distomes. Large numbers of snails collected from the Marg Canal, near Cairo, were found to be infected with larval forms showing this feature of the Bilharzia (*Schistosomum*) group. The cercariæ were found in four different species—*Planorbis mareoticus*, *P. boissyi*, *Melania tuberculata*, and *Bullinus contortus*. Tame white rats and variegated mice, the Egyptian desert rat, guinea-pigs, and Mangaby monkeys were successfully infected with cercariæ derived from the water-snails. Experiments with monkeys showed the probable correctness of

* Parasitology, viii. (1915) pp. 22–40 (2 pls.).
† Parasitology, vii. (1915) pp. 339–78.
‡ Journ. R.A.M.C., xxv. (1915) pp. 1–55 (22 figs.).

the view that cercariæ taken into the mouth in drinking water may adhere to the mucous membrane of the mouth, tongue and œsophagus, and at once proceed to penetrate into the tissues. As in ankylostomiasis, there is little doubt that the infection occurs through the skin in the bulk of cases, but experiment shows that it may also be oral.

The author points out some conclusions of his inquiry:—Transient collections of water are quite safe after recent contaminations; permanent collections of water, such as canals, are potentially dangerous because of the presence of the essential intermediary host; the removal of infected persons from a given area would have no effect, at least for some months, in reducing the liability to infection, as the intermediate hosts discharge infective agents for a prolonged period; infected troops cannot re-infect themselves or spread the disease directly to others, they could only convey the disease to those parts of the world where a local mollusc could efficiently act as carrier; infection actually takes place both by the mouth and through the skin, recently contaminated earth or water is not infective; infection in towns is acquired from unfiltered water; eradication can be effected without the co-operation of the infected individuals by destroying the molluscan intermediaries.

In a continuation * of his account of his investigations on Bilharzia, Leiper deals with prevention and eradication. The life of the Bilharzia outside the body may be divided into three periods: (1) That between the passage of the egg into water and the entrance of the hatched parasite into the mollusc; (2) the stage of metamorphosis within the mollusc; and (3) that prior to the entrance of the free-swimming cercaria into the human body after it has left the mollusc. It is universally recognized that in Egypt under present circumstances it is practically impossible to prevent the contamination of water with infected urine and fæces. In order to break the life-cycle of the Bilharzia worm one must find some simple means of destroying it during the free-swimming infective stage, or of depriving it of its essential intermediate host. The former is the line of attack suited to the conditions under which bilharziosis is acquired in large towns; the latter is applicable to country villages and districts. If the unfiltered water of Cairo could be stored for two days, or a day and a half, there is no doubt that it would become practically free from danger as far as bilharziosis is concerned. The cercariæ do not remain alive for more than thirty-six hours. The stored water would lose its heavy sediment which is of great manurial value for gardens. Against this loss may be set the fact that, at present, one-third of the 30,000 children born annually in Cairo become infected with Bilharzia.

In agricultural districts some means must be found to stamp out the molluscs harbouring Bilharzia in the places where they congregate and multiply. Periodic drying, treatment with ammonium sulphate, and other methods are discussed.

The cercariæ move by looping along or by swimming. They crawl rapidly over any surface by alternate use of the oral and ventral suckers, the tail being dragged passively behind. When they swim, the tail and

* Journ. R.A.M.C., August, 1915, pt. 2, pp. 147–81 (figs. 25–39).

the whole body gyrates and the cercaria progresses with the pronged tail foremost. Swimming is not continuous. Brief periods of activity are regularly alternated with periods of rest. During the latter the cercaria very slowly sinks. When seen with a hand-lens their attitudes recall those of minute mosquito larvæ. As a rule they frequent the surface, but when a small mammal like a mouse is placed in the water they at once attack the skin. As successful infection resulted in a young mouse after only ten minutes' immersion on a single occasion, they appear to be able to pierce the skin very rapidly. An infected mollusc, such as *Planorbis boissyi*, may continue to discharge cercariæ for three weeks, but the cercariæ do not live in the water for longer than about thirty-six hours. In ordinary tap-water they usually live about twenty-four hours. They cannot withstand the slightest desiccation; they are very sensitive to scarcity of oxygen; they are killed if the temperature of the water be momentarily raised to 50° C.; they are inhibited by weak acids and stimulated by very weak alkalis. Free-swimming cercariæ pass through the finest silk mesh, through stocking material, and, given time, through several inches of sand if there is a continuous flow of water. Unlike the Ankylostome larvæ, they are unable to traverse ordinary filter-paper.

For chemical sterilization of water, tabloids of sodium bisulphite are effective. A dilution of 1 in 1000 is rapidly lethal to the Bilharzia cercariæ. Personal contact of any kind with unfiltered water is risky. When water is stored, in order to destroy the cercariæ care must be taken to screen the intake pipe with gauze to keep out infective molluscs. The water of wells and "sakias" is much safer than that from other sources. Hitherto molluscs have not been found in these wells. Shallow barrel sand-filters are open to suspicion, for the cercariæ can get through the sand. The reproductive activity of Bilharzia in the molluscs is probably most intense during the summer months, but the occurrence of mature cercariæ in infected molluscs in February shows that there is a certain liability to infection throughout the year.

In a third paper * the author continues his account of Bilharzia. The life-history is that of a typical digenetic Trematode. The miracidium gives rise to a sporocyst, which in turn produces daughter-sporocysts. After leaving the mother-cyst the daughter-sporocysts migrate into the tissue of the digestive gland of the water-snail and grow rapidly. They become greatly elongated and eventually ramify throughout the organ, so increasing its bulk that an infected *Planorbis* can be detected at a glance. The colour of the organ is also changed, that of *P. boissyi* turning from dark brown or black to ochre.

The ends of the daughter-sporocysts are solid, but the walls of the tubular bodies are very delicate and transparent. As the cercariæ develop within them, the sporocysts may be constricted by the host tissue and division may result. As there is no oral sucker or gut, the nutriment must be absorbed. The sporocysts are capable of travelling by wriggling movements. The cercariæ leave the sporocyst by rupture of the wall, and they are discharged from the snail in "puffs," a number

* Journ. R.A.M.C., xxvi. (1915) pp. 253-67 (figs. 41-55).

being periodically discharged into the water. This is independent of the passage of fæces by the snail.

The cercaria consists of a body and a Y-shaped locomotor tail (furcocentrous). It is the only infective stage. They penetrate the skin and the mucous membrane of mouth and gullet. All stages of entry were observed. They pass to the portal system. Figures are given of all the phases from the cercaria before it enters its definitive host to the paired egg-producing adults two months later. A certain number probably enter the blood-stream direct, while others pass first through the lymphatic system.

### Echinoderma.

**Present-day Crinoids.***—Austin Hobart Clark has published the first part of a monograph on existing Crinoids. It deals with the general structure of the Crinoids, and with Comatulids in particular, and is preceded by an introduction, a history, and a glossary. Because of the extraordinary completeness of the palæontological record and the small number of recent species hitherto known, the Crinoids have been studied too much from the palæontological side, but the author emphasizes the present-day abundance of species and individuals alike, and the important part they play in the ecology of the floor of the sea in certain regions. A detailed account is given of Crinoid structure, especially as regards the skeleton, and the author defends his startling theory that Echinoderms are related to Crustaceans, and to barnacles in particular.

**Revision of Palæozoic Stelleroidea.**†—Charles Schuchert has made an important revision of the Palæozoic Asterids, and has also dealt in part with the Auluroidea from which the true Ophiuroidea arose, probably in late Devonian times. Seven families of Palæozoic Asterids are recognized, which seemingly had their origin in *Hudsonaster* or some form like it. The family Hudsonasteridæ represents the primitive stock. The genus *Hudsonaster* includes small rigid Asterids with few and comparatively large ossicles, nearly all of which belong to the primary skeleton. They are massively and simply built, with the spines rudimentary and restricted to the adambulacrals and inframarginals. From *Hudsonaster* the evolutionary tendency was to get rid of the rigidity and ponderosity through the comparative reduction in size of the plates and the introduction of many smaller secondary pieces, along with an abundance of spines. Other tendencies were towards elongation of rays, with greater flexibility and greater power of locomotion through the indefinite duplication of pairs of podia, and increase of body cavity in three different ways. This took place through the development of interbrachial areas (*a*) by the inward crowding of the single interbrachial axillaries, followed by more and more pairs of proximal inframarginals ; (*b*) through the insertion of an indefinite number of accessory ossicles between the adambulacrals and the inframarginals, forcing the latter more outward ; and (*c*) through the introduction of supernumerary

* U.S. Nat. Mus., Bull. No. 82, pp. 1–406 (17 pls. and 513 figs.).
† Smithsonian Inst. U.S. Nat. Museum, Bull. No. 88 (1915) pp. 1–311 (33 pls.).

rays, perhaps an abnormal change arising in the later larval life. With these changes on the actinal side there must have been compensating abactinal changes. One line evolved through the elongation of rays, flexibility, and the increase in size of the oral region by the (*a*) method, from the primitive Hudsonasteridæ into the derived Palæasteridæ, Promopalæasteridæ, Xenasteridæ, and Neopalæasteridæ. This was the most satisfactory line of evolution, resulting in the greatest variety of genera. Another line, starting with *Hudsonaster* as radicle, was established through the increase of the body cavity by the (*b*) method, giving rise to the Palasterinidæ. This was not so prolific in genera as the former. Finally, a third phyletic line was established through larval adaptation, causing a sixth ray to develop and thereafter pairs of rays, resulting in the multi-rayed Asterids of the family Lepidasteridæ.

## Cœlentera.

**Inheritance in Asexual Reproduction of Hydra.***—K. S. Lashley finds that within a wild population of *Hydra viridis* there are hereditarily diverse races which differ in the number of tentacles at separation from the parent, in their size at a given age, and less certainly in other characters. The differences between such races are permanent so long as the races are kept under the same environment. The evidence favours the view that the differences are truly genotypic (i.e. due to hereditary constitution), but the reservation is made that they are possibly the result of differences in the age of the clones. (A clone is a family descended from a single individual by asexual reproduction.)

In the absence of selection the strains remain distinct. Within populations there is a correlation between the characteristics of parents and progeny and of other close relatives, which is largely due to the existence of these diverse strains. Within the clone there is no significant correlation between the variations of close relatives in the initial number of tentacles. Within the clone there is a slight correlation between the number of tentacles of the buds and the number of tentacles which their parents bear when each bud is produced.

Diversities of environment tend to produce like-variations in parents and offspring, and this likeness tends to disappear when the environmental cause is removed. The existence of such environmental agents is sufficient to account for the ancestral correlations found, even though there is no inheritance of variations.

Continued selection of variants in tentacle-number results in changes in the vigour of the selected groups. This results in an apparent diversity of the differentially-selected groups, but the diversity persists only during selection, and disappears at once when selection is discontinued. Variation in the number of tentacles of *Hydra viridis* is not inherited.

There is a positive correlation between the variations in the size of parent and offspring within the clone. The statistical evidence of an external cause of this correlation is presented, but from general con-

* Journ. Exper. Zool., xix. (1915) pp. 157–210 (10 figs.).

siderations it seems probable that this, like the correlation of variations in the number of tentacles, is due wholly to the similar action of environmental agents upon parent and offspring.

**Note on Hydra oligactis.***—Baini Parshad reports finding a specimen with seven tentacles, many with four, and some with five. Nelson Annandale has noted that he has not seen Indian specimens with more than six tentacles. The food consisted of young stages of the aphis *Siphocoryne nymphæ* which infested the pond-weed on which the Hydra was growing.

**Tasmanian Hydroids.**†—E. A. Briggs reports on a collection of fourteen Tasmanian Plumularids, eight of which are recorded for the first time from the eastern coast of Tasmania. The collection included *Plumularia procumbens* Spencer, *P. sulcata* Lamarck, *Aglaophenia armata* Bale, *A. tenuissima* Bale, and *Nemertesia ciliata* Bale. There seems to be a considerable amount of variation in the details of the last-named species, which was described by Bale in 1914.

**Heliotropic Reactions of Eudendrium.**‡ — Jacques Loeb and Hardolph Wasteneys have inquired into the relative efficiency of various parts of the spectrum for the heliotropic reactions of the hydroid *Eudendrium*. Their experiments have shown that the most efficient region in the spectrum for the production of heliotropic curvatures is situated in the blue at 4735 Å . *u*. This region coincides approximately with the one found by Blaauw for the seedlings of oats (4780 Å . *u*). The regions in the red, orange and yellow are practically without effect in both *Eudendrium* and *Avena*, and it is concluded that the heliotropism of the sessile animal *Eudendrium*, and that of the sessile plant *Avena*, are identical even as regards the most efficient wave-length.

**Ctenophora of Chilka Lake.**§—Nelson Annandale and Stanley Kemp found in Chilka Lake a race (*bengalensis*) of *Pleurobrachia globosa* Moser, a species originally described from the Malay Archipelago. It occurs for a great part of the year over the whole of the lake, but disappears in the fresh-water season, and does not reappear until the water has regained a certain salinity. The typical form of the species has not been found in the Indian Ocean, but Browne has described another race (*ceylonensis*), from the Gulf of Manaar. In many of the specimens from Chilka Lake, the jelly, more particularly in the neighbourhood of the stomodæum, funnels and tentacle-sheaths, contains a large number of minute and apparently immature Distomid Trematodes. They are accompanied by eggs, hardly smaller than themselves, resembling those found in the canals of the young of *Acromitus rabanchatu*. On the external surface of a few of the Ctenophores there were Protozoa of the genus *Trichodina*.

* Records Indian Museum, xi. (1915) p. 349.
† Journ. Proc. Roy. Soc. New South Wales, xlviii. (1915) pp. 302–18 (2 pls.).
‡ Journ. Exper. Zool., xix. (1915) pp. 23–35.
§ Mem. Indian Museum, v. (1915) pp. 117–8.

**Medusæ of Philippines and Torres Straits.***—A. G. Mayer reports on thirty-one Scyphomedusæ from the Philippines, including four new species: *Cotylorhiza pacifica*, *Catostylus townsendi*, *Lychnorhiza bornensis*, and *Phyllorhiza luzoni*: and on six Scyphomedusæ and ten Hydromedusæ from the Torres Straits, the Hydromedusæ including *Eutima australis* sp. n. Only one Scyphomedusa (*Catostylus mosaicus*) and one Hydromedusa (*Eutima australis*) are possibly peculiar to Australia; the others are of wide distribution.

The discovery of a Philippine species of *Cotylorhiza* allied to the species known from the Mediterranean is interesting, but the most curious Philippine genus is *Lobonema*, in which the marginal lobes of the bell are gradually extended and superficially resemble tentacles, tapering gradually throughout their length to pointed tips. They are not capable of contraction, and their function is problematical.

Mayer gives a general account of the Scyphomedusæ, and we may refer to a few points of special interest. The minute sense-organs, which occur as pigmented specks at regular intervals around the margin, contain calcium oxalate crystals. It is probable that sodium oxalate is constantly forming in the sense-club; that the calcium chloride of the sea-water entering the sense-club forms a precipitate of calcium oxalate, setting free sodium chloride, which is a powerful stimulant for the nerves, thus causing the pulsating reaction. Moreover, Cary has shown that if the sense-organs be removed, the first stages in regenerating another wound are slow. If even a single sense-organ be present, regeneration proceeds at once and with rapidity. The pulsation stimulus in jelly-fishes is conducted by the nerves, whereas in the Vertebrate heart it is conducted by the muscles. Nerve conduction in *Cassiopea* is chemically described as a reaction, in which the cations of sodium, calcium, and potassium take the active part, while magnesium is passive. The sodium, calcium, and potassium appear to be attracted by absorption to the surfaces of some negatively-charged celloidal elements of the nerve, and the velocity of nerve conduction is proportional to the degree of concentration of these absorbed cations.

The stinging-cells on the tentacles and other parts appear to secrete formic acid. Large jelly-fishes paralyze many fishes; but some small fishes, accompanying jelly-fishes and even biting off pieces of them, enjoy a protection from larger fishes which dare not venture so near. The gelatinous substance of a jelly-fish may serve as a store of food, and specimens of *Cassiopea* can live at least forty-two days without food, the weight declining to less than one-hundredth of the original. The loss of weight on each day is, however, proportional to the weight of the animal at the beginning of that day, and thus the lighter the animal becomes the less weight is lost.

Scyphomedusæ are exclusively carnivorous. The largest forms occur in cold seas, where the floating animal life is more abundant than in the tropics. The gastro-vascular system is both "chymiferous" and digestive. The function of the gastric cirri is not known.

The sexes are usually separate in Scyphomedusæ. In rare cases, as

* Carnegie Inst. Washington, Publication No. 212, pp. 157–202 (3 pls. and 7 figs.).

in *Chrysaora*, they are hermaphrodite, or male when young and female when old. When mature at the breeding season the males and females usually come to the surface in great numbers, and may form vast swarms many square miles in extent. The pear-shaped ciliated planulæ settle down with the anterior end downwards, and the mouth and tentacles appear at what was the posterior end.

The Scyphomedusæ include five main orders:—Carybdeidæ or Cubomedusæ, Stauromedusæ, Coronatæ, Semæostomata (such as *Aurelia aurita*, which occurs from pole to pole), and the Rhizostomeæ. As examples of convergence attention is directed to the Holothurian *Pelagothuria*, which bears a wonderfully close resemblance to a jelly-fish, and swims actively through the water in the tropical Pacific, and to *Craspedotella*, a Protozoon, "which would certainly have been mistaken for a jelly-fish had it not been of microscopic size."

**Notes on Philippine Stolonifera and Xeniidæ.***—S. F. Light describes the flower-like beauty of the large distinct polyps of the Philippine species of *Anthelia* and *Xenia*. "With their beautiful iridescent shades of blue and green and rich velvety brown, their gracefully flexible polyps waving with the currents, and their slender feather-like tentacles, they present a picture of unusual grace and charm. The smaller, shorter, and more rigid star-like distal moieties of *Tubipora*, or of *Clavularia violacea* Quoy and Gaimard with their solid green, blue, or light velvety brown colours, present a decidedly different appearance, but one as distinctly pleasing; and the sudden change which takes place when the colony, disturbed by some sudden jar or by a shadow, suddenly retracts the distal moieties of its polyps, exposing the red expanse of the rest of the colony, is very startling."

The Philippine forms belong to the genera *Cornularia*, *Anthelia*, *Clavularia*, and *Sympodium*. Attention is directed to the large gland cells which occur in the columnar epithelium of the stomodæum in *Clavularia viridis* and other forms. Scattered at more or less regular intervals in the inner portion of the stomodæal wall are numerous short cells, each containing an oval nematocyst about 0·009 mm. in length with a spirally coiled thread. Perhaps this is the first case in which nematocysts have been found in the stomodæal wall of an Alcyonarian.

Hickson spoke of horny skeletal elements being present in wide lacunæ in the mesoglœa of *C. viridis*, Light regards these as the nuclei of spicule-forming cells. The true skeletal fibres are in the ectoderm. In *C. violacea* Quoy and Gaimard there is no trace of pinnules, and the author calls attention to many other peculiarities, such as the presence in the distal moiety of an ectoderm of very high columnar epithelium which is strikingly different from that of any other known Alcyonarian, the enormous development of the muscular ridges of the mesenteries, and the peculiar structure of the swollen upper portion of the mesenteries in which the mesoglœa is finely reticulated, and contains numerous symmetrically placed, deeply staining, irregularly shaped bodies.

* Philippine Journ. Sci., x. (1915) pp. 155–67.

## Porifera.

**Sponges of Chilka Lake.***—Nelson Annandale reports on the sponges from this large lagoon on the east coast of Peninsular India. It is connected with the Bay of Bengal. Its area is about 350 square miles: its depth rarely exceeds two fathoms. Seven sponges occur, fresh-water and marine forms growing together in an intimate manner. The list includes *Spongilla alba* Carter, *Sp. nana* sp. n., *Cliona vastifica* Hancock, *Suberites sericeus* Thiele, *Laxosuberites aquæ-dulcioris* Annandale, *L. lacustris* sp. n., and *Tetilla dactyloidea* (Carter) var. *lingua* nov. Remarkable variations are exhibited by most of the species, and these can be definitely correlated with differences in environment. It is evident that all the species are able to withstand, by one means or another, great changes of salinity. In *Laxosuberites lacustris* the simple gemmules which are characteristic of the Suberitidæ have been replaced by aggregates of gemmules. They are piled together, one on the top of another in several layers, and are held in this position by vertical spicules which transfix them. Lichenoid coherent masses of gemmules, which can be detached as a whole, are thus formed, instead of a single adherent layer as in *L. aquæ dulcioris*. Masses separate off when the sponge dries in hot weather and may float away to other less exposed places. The skeleton of *Spongilla alba* is strikingly modified to withstand the violence of the waves in exposed positions in the lake.

## Protozoa.

**Cyst of Amœba proteus.**†—Lucy Agnes Carter describes a cyst of this species. The only previously recorded observations on the encystment of *Amœba proteus* are those of Scheel in 1899. The cyst is spherical and free, covered with detritus and two membranes. It is from $70\,\mu$ to $140\,\mu$ in diameter in life, shrinking to from $60\,\mu$ to $110\,\mu$ after preservation. A combined study of the process of encystment, as seen in life and in the sectional cysts, leads to the conclusion that after the cementing of the debris the amœba-body withdraws itself from its protective envelope, and, rounding itself off, forms its outer membranous wall. After this a slight contraction of the protoplasm as it concentrates, and the formation of the second membranous wall, completes the protection of the now encysted amœba. As the cyst ripens, the membranous walls contract and crumple: the wall of debris remains intact till the young amœbæ are ready to escape. The period of encystation lasts from ten to twelve weeks.

Inside the cyst the nucleus breaks down, the chromatin and plastin are distributed throughout the cytoplasm, secondary nuclei are formed. These are of the protokaryon type, showing a relatively large karyosome slung up in the nuclear sap by achromatin radiating fibres, each terminating in a chromatin granule similar in all appearance to the karyosome, but retaining the stain less intensely. The nuclei then cut

* Mem. Indian Museum, v. (1915) pp. 23–54 (3 pls.).
† Proc. R. Phys. Soc. Edinburgh, xix. (1915) pp. 204–12 (1 pl.).

off portions of the cytoplasm, forming 75–100 young amœbæ. As Scheel's account differs in some important respects from that now given, it is suggested as not improbable that there may be two types of cyst in *A. proteus*, just as has been shown to be the case in *A. minuta*.

**Effects of Salt Solutions on Heat Resistance of Paramecium.***—R. H. Hutchison cultivated two pure lines of *P. caudatum*, one in a medium of decided alkaline reaction, the other in a slightly acid medium. Experiments with the former showed that the addition of weak solutions of common salt, calcium chloride, and potassium nitrate had a marked protective action, increasing the heat-resisting powers of the race. So does distilled water. Individuals from the acid medium, on the other hand, were adversely affected by the addition of weak solutions of common salt and calcium chloride, and also by distilled water. The conclusion is drawn that certain undetermined properties of the medium affected the ability of the Infusorians to withstand heat. The effects of continued exposure to moderately high temperatures on the death temperatures were studied. Two cultures were kept in a water bath, the temperature of which ranged from 22°–30° C. The mean death temperature of these two strains fluctuated considerably, and at times was about 1° above the highest mean death temperature of a control culture kept in a cool room. But this increase above the control was not constant, and on the whole no very decided effect was produced.

**Infusorian Fauna of Lake Maggiore.**†—Emile André reports the occurrence of a large number of Infusorians from this lake, including *Anoplophrya simplex* sp. n. from the intestine of a large Lumbricid living under the stones at the delta of the Maggia, and a pelagic form, *Acarophrya helenæ* g. et sp. n., allied to *Holophrya* in the family Holophryidæ, but without a nucleus and with a projecting pharynx. It may be that the nucleus is in a diffuse state. The whole posterior part of the cell is occupied by a large slowly pulsating contractile vacuole.

**Protozoa from Fishes.**‡—Thomas Bentham reports on a number of Protozoa found as parasites in fishes from near Cullercoats. He obtained *Hæmogregarina cotti* Brumpt and Lebailly from *Cottus scorpius*, and also from *Calliobdella punctata*, the *Cottus* leech. It seems probable that schizogony occurs in the spleen of the fish, and the gamogonous cycle in the gut of the leech. An infusorian of the genus *Trichodina* was found on the gill-rakers of the fish, and is carefully described, Hæmogregarines from the mackerel and the skate are also described.

**Multiplication-Forms of Trypanosome in Body of Rat.**§—A. C. Coles has found in the lung and heart blood of the *Mus decumanus* many of the stages described by Minchin and Thomson in the rat-flea. He has seen the recurved, the pear-shaped, the coiled-up Trypanosomes

* Journ. Exper. Zool., xix. (1915) pp. 211–24 (1 fig.).
† Revue Suisse Zool., xxiii. (1915) pp. 101–8 (2 figs.).
‡ Ann. Nat. Hist., xvi. (1915) pp. 381–92 (2 pls.).
§ Parasitology, viii. (1915) pp. 184–9 (1 pl.).

and probably spheres, "the final stage of intracellular multiplication." In quite young rats he found all stages of forms dividing by equal and unequal fission ; forms with a very long posterior end ; irregular types with three or four nuclei, three or four centrosomes, and three or four flagella.

**Herpetomonads in Mice.*** — H. B. Fantham and Annie Porter have found herpetomonads (or leptomonads) in mice. They are led to the conclusion that the origin of the infection is to be sought in a flagellate of an ectoparasite of the mouse. This flagellate is very probably *Herpetomonas pattoni*, a natural or specific parasite of fleas (especially rat-fleas), which can adapt itself to life in the blood of mice. Herpetomonads have been recorded from rat-fleas, dog-fleas, and human-fleas. It is probable that the flagellates are varieties of one species, *H. pattoni*, which can live in the blood and certain internal organs of rats, mice, dogs and man.

**Chromosome Cycle in Coccidia and Gregarines.†** — Clifford Dobell and A. Pringle Jameson have studied, respectively, the coccidian *Aggregata eberthi* Labbé and the gregarine *Diplocystis schneideri* Kunstler. Their investigation of these two organisms has shown that the nuclear divisions at all stages in the life-histories are mitotic, and that the chromosome numbers are remarkably constant.

In *A. eberthi* the chromosomes are six in number at every nuclear division in the life-history with one exception. This is the division of the zygote nucleus immediately succeeding fertilization. There are here twelve chromosomes, which become halved to six in the course of this division. Reduction thus occurs immediately after fertilization — not during gametogenesis. The six chromosomes must be regarded as representing the haploid number — the diploid number (twelve) being present in the zygote nucleus only, while its division is a reduction division. Since the haploid number (6) occurs in both the sexual and the asexual cycle, there is thus no differentiation in respect of chromosome number in the two generations.

In *D. schneideri* the number of chromosomes in all the nuclear divisions is, with one exception, three. At the first mitosis in the spore, six chromosomes are formed by the segmentation of the spireme thread. These separate into two homologous groups of three each, which represent the two sets of chromosomes derived from the two gamete nuclei which united to form the nucleus of the zygote. This first division in the spore—immediately following fertilization—must, therefore, be regarded as a reduction division. The haploid number of chromosomes is three, and occurs in all the nuclear divisions of the gamont, and in all the spore divisions except the first. The diploid number is six, and is found at only one division in the whole life-cycle—the first sporal division, immediately following fertilization. Reduction thus occurs directly after fertilization, and not during gametogenesis.

"It is clear that the chromosome cycle of *Aggregata* agrees, in

* Parasitology, viii. (1915) pp. 128–32 (7 figs.).
† Proc. Roy. Soc., Series B, lxxxix. (1915) pp. 83–94 (2 figs.).

principle, with that of *Diplocystis*. In both forms the haploid number of chromosomes is found in every nucleus throughout the entire life-history, with the single exception of the zygote nucleus. This is a diploid nucleus, containing two haploid groups of chromosomes derived from the two gamete nuclei which entered into its formation. The division of this nucleus is, in both *Aggregata* and *Diplocystis*, a reduction division, which reduces the diploid number to the haploid once more. From the point of view of the chromosomes, it is thus clear that the first division of the sporont nucleus of *Aggregata* is not homologous with the first division of the "sporont" (gamont) nucleus of *Diplocystis*, but with the first division of its spore nucleus—since these are the divisions during which the chromosome numbers are halved."

It should be noted (1) that this is the first demonstration of a chromosome cycle in the Protista; and (2) that the reduction does not occur during gametogenesis. The authors regard the supposition that reduction occurs during gametogenesis in the Coccidia and Gregarines as an incorrect analogy drawn from other animals.

**New Polycystid Gregarine.***—Shigemi Ishii describes from the food-canal of a Diplopod (*Fontaneria coarctata* Pocock) a curious Gregarine—*Spirosoma caudata* g. et sp. n.—showing conspicuous spiral striation in the posterior part of the body. The sporonts are always solitary. The protomerite is short and generally conical, with a pore-like structure at the apex in the younger stages at least. The deutomerite is large and elongate, divisible into two parts, the broad anterior and the narrow posterior. The epicyte of the protomerite and of the broad anterior part of the deutomerite shows the ordinary fine longitudinal striation, while in the tail this takes a spiral course and is less dense. The sarcocyte is well developed. The endocyte is dense. The nucleus in the broad anterior part of the deutomerite is large and vesicular, containing a single large spherical karyosome, sometimes with a small vacuole.

**Hæmatozoa of Australian Batrachians.**†—J. B. Cleland continues his studies of these, and has examined blood films from eighteen species. Only two species showed Hæmatozoa, *Hyla cærulea* showing *Hæmogregarina* (*Lankesterella*) *hylæ*, and *Limnodynastes tasmaniensis* showing *Trypanosoma rotatorum* in very pleomorphic representation.

* Annot. Zool. Japon, ix. (1915) pp. 7–9 (2 figs.).
† Journ. Proc. Roy. Soc., New South Wales, xlviii. (1915) pp. 412–4.

# BOTANY.

## GENERAL.

### Including the Anatomy and Physiology of Seed Plants.

### Cytology,

#### including Cell-Contents.

**Spirogyra-cells under Action of Centrifugal Force.***—E. W. Schmidt describes the behaviour of *Spirogyra*-cells after subjection to high centrifugal force. He subjected filaments of the alga to various degrees of centrifugal force up to 8,320 revolutions a minute. The nucleolus was never seen to fly out of the nucleus, though other interesting phenomena occurred. The power of regeneration of the contents was most marked, especially the return of the chloroplasts which had been hurled against the cell-wall. Fine filaments of cytoplasm, which are formed soon after the recovery of the cells, take part in this return. Whether they actively draw the chloroplasts or whether the chloroplasts are pushed by protoplasmic streams is undetermined.

**Pigments of Fruits of Capsicum.**†—W. R. G. Atkins and G. O Sherrard have studied the pigments of the fruit in relation to some genetic experiments on *Capsicum annuum*. The unripe fruits are green as a rule, but pale yellow in one form: in the four varieties employed the ripe fruit is red, chocolate, orange, and yellow respectively: red is found to be dominant to yellow, and appears to be a simple dominant to chocolate and orange. The different shades of green in unripe fruits are due to variations in the numbers of chromatopheres contained in each cell. The colours of the ripe fruits are due to red, chocolate, orange, and yellow plastid-pigments; it has not been possible to show that the red or the chocolate is due to a mixture of pigments. Some red fruits contain small quantities of yellow pigment soluble in water. The red and chocolate pigments when pure are oily liquids which have not been obtained in a crystalline state: this character, and their ready solubility in cold alcohol and in petroleum ether, distinguishes them from lycopin, carotin and xanthophyll. The above solutions become colourless when allowed to evaporate in sunlight. The amount of peroxidase present in all Capsicum fruits appears to diminish as they ripen, and bears no simple relation to the variety of fruit. The enzyme is frequently present only in the epidermis, while the deeper tissues may contain an inhibitor with a strong reducing action.

* Ber. Deutsch. Bot. Gesell., xxxii. (1914) pp. 35–47. See also Bot. Centralbl., cxxix. (1915) p. 440.

† Sci. Proc. R. Dublin Soc., xiv. n.s. (1915) pp. 328–35.

## Structure and Development.

### Vegetative and Reproductive.

**Methods in Plant Histology.***—The present issue is the third revised edition of the original work, which appeared in 1901; the second edition was published in 1905. The book is well-known in botanical laboratories, and the latest version renders it an up-to-date handbook for the practical student of the minute structure of plants. During the past ten years methods have become more and more exact, and their exhaustive treatment renders the present volume practically a new book. Great improvements have been made in the paraffin method, so that sections are easily cut which were impossible ten years ago, and ten years of further experience with the venetian turpentine method have made it possible to describe it with greatly increased definiteness. The subject-matter is divided into two parts. The first contains a description of apparatus, reagents for killing, fixing, clearing, etc., the various stains, and general remarks on staining and mounting. The different methods—freehand, glycerin, venetian turpentine, paraffin and celloidin—are described in detail, and there is a chapter on special methods for various special cases. A chapter has been added on photomicrograph and lantern slides. The second part consists of specific directions for applying the methods described in the first part to a selected series of forms representing the various plant-groups from mycetozoa and algæ up to angiosperms. Helpful directions are given for collecting and growing laboratory material. There is a chapter on using the Microscope, and one describing a class list of preparations suitable for a student's course. Many of the illustrations are photomicrographic reproductions.

**Vascular Anatomy of the Megasporophylls of Conifers.**†—Hannah C. Aase, as a result of the study of the origin and course of the vascular bundles which supply the sporophylls and tracts in a representative series of genera and species, tabulates the following conclusions:—Two general tendencies are apparent in the evolution of the ovulate strobilus, namely, the reduction in number of sporophylls and the modification of a compound into an apparently simple sporophyll; the latter generally implies loss of one of the two parts of the sporophyll or their union. Reduction has reached its highest expression in members of the Cupressineæ, Taxineæ and Podocarpineæ; one type of reduction is represented by the general sterilization and reduction of parts in the lower sporophylls of *Pinus*. Simplification of a compound sporophyll is most fully realized in *Arthrotaxis selaginoides*, *Agathis* and *Saxegothæa*; an extensive reduction of the bract occurs in *Cedrus* and the lower sporophylls of *Pinus maritima*: the scale in *Phyllocladus* is probably reduced so as to be represented only by a distinct ovular supply; the union of the

* By Charles J. Chamberlain, pp. xi and 314 (107 figs.). University of Chicago Press; published in the United Kingdom by the Cambridge University Press, London.

† Bot. Gaz., lx. (1915) pp. 277–313 (figs.).

two parts is complete in *Juniperus* and *Chamæcyparis*. A fusion of the vascular supplies does not run directly parallel with fusion of bract and scale. Separate origin of the vascular supplies occurs most generally in the Podocarpineæ and Abietineæ; fusion of the supplies is best shown in the Araucarineæ; both types of bundle-origin are represented in the same strobilus in *Cryptomeria*, *Cupressus Benthamii*, and the lower sporophylls of *Pinus*. The bract-bundle in plants with uninerved foliage-leaves divides only slightly, if at all; the extent of the scale bundle-system is directly related to the size of the organ supplied. The scale-bundles in the Abietineæ and *Chamæcyparis* form in the expanded portion of the organ a straight row or arc; in members of the Taxodineæ and Cupressineæ scale-bundles swing round so as to lie at each side of the bract-bundle. In *Cryptomeria* and *Cupressus Benthamii*, and perhaps *Cunninghamia Davidiana*, scale-bundles accompany the bract-bundle into the free portion of the bract. A branching bundle in the foliage-leaf in *Araucaria* and *Agathis* probably implies a branching bundle in the bract of the sporophyll; the vascular system in the megasporophyll is probably a complex of bract- and scale-bundles. In species of *Podocarpus* the scale-bundles continue in the portion of the scale folded towards the dorsal side, forming the epimatium of the ovule.

**Gynœcium of Parinarium.***—H. O. Juel publishes a paper dealing with the systematic position of *Parinarium* and other members of the Chrysobalanoideæ. The author has studied two forms, viz., *P. curatellifolium* var. *fruticulosum* and *P. bangweolense*, and finds that in the early stages of development of the gynœcium of the former there are three rudimentary carpels, corresponding to the tripartite stigma. In normal flowers both the posterior chambers are sterile and undeveloped, but the mature ovary is bilocular, owing to the formation of a false partition. Not infrequently, however, abnormal flowers arise in which there are three distinct chambers. In *P. bangweolense* reduction is more complete, but abnormal flowers appear to indicate a tricarpellary condition. The author is of the opinion that the *Parinarium* type of gynœcium is based upon a trimerous form similar to that found in the Limnanthaceæ. Although the other genera of this group have not yet been examined, it seems probable that all the Chrysobalanoideæ are alike in this respect, and that their relationship to the Prunoideæ is doubtful. Although syncarpy is found in other divisions of the Rosaceæ, e.g. in the Pomoideæ, dissimilarity in other respects makes it impossible to connect them with the Chrysobalanoideæ. The only feature connecting the latter with the Rosifloræ is that of perigyny, a feature which is not, however, confined to this group. The author concludes that while the evidence justifies the separation of the Rosaceæ and Chrysobalanoideæ, it is insufficient at present to allow of the removal of the latter group from the Rosifloræ.

**Embryo-sac of Plumbagella.**†—K. V. O. Dahlgren publishes a paper dealing with a new type of embryo-sac. The author finds that

* Arkiv Bot., xiv. No. 7 (1915) pp. 1–12 (6 figs.).
† Arkiv Bot., xiv. No. 8 (1915) pp. 1–8 (5 figs.).

while in the Staticeæ the nuclei divide as usual and form an eight-nuclear embryo-sac, the closely related group of the Plumbagineæ behave in a totally different manner. The species upon which most of the observations were carried out was *Plumbagella micrantha*, but three species of *Plumbago* and *Ceratostigma plumbaginoides* all exhibit the same peculiarity in their embryogeny. After the two meiotic divisions no further division takes place, but the four macrospore nuclei constitute the embryo-sac. The uppermost nucleus becomes the nucleus of the egg-cell, the lowest the antipodal nucleus, and the remaining two the polar nuclei. The two latter fuse very early, some time before fertilization. No synergidæ are ever present. It is probable that a secondary embryo-sac nucleus is formed, although it has not yet been observed. The antipodal nucleus and cell soon disappear. At the time of fertilization the pear-shaped egg-cell fills the upper part of the embryo-sac; its plasma is mainly confined to the broad lower end, while in the upper part is a large vacuole. The endosperm-nucleus lies close against the egg-cell. The actual process of fertilization has not yet been seen. Thus the Plumbagineæ appear to represent the utmost limit, at present observed, of the tendency in the higher plants to reduce the gametophyte to an organ of the sporophyte generation. The author likewise points out the surprising similarity in the results of the reduction-division in this group, and in animals, and shows that it is conceivable that cases may occur where the embryo-sac and the egg-cell are identical.

**Cratægo-Mespilus Graft-hybrids.***—J. Meyer has studied the two "graft hybrids" described by Bronvaux, which originated from the callus formed at the junction between a *Cratægus monogyna* stock and a scion of *Mespilus germanica*. Few distinguishing features occur between the tissues of *Cratægus* and *Mespilus*, but the chromosomes of *M. germanica* are longer and thinner than that of *C. monogyna*. The capacity to produce anthocyan is present in the epidermis of the fruits of *Cratægus*, but lacking in fruits of *Mespilus*, while, on the other hand, *Mespilus* flowers turn reddish in ageing, while those of *Cratægus* remain white. There are also differences in the shape of the epidermal cells and the cuticle. The author supports the view of Baur, that these two "graft-hybrids" consist of a core of *Cratægus* tissue overlaid by a mantle of *Mespilus*. In one of the two the mantle is a single epidermal layer, while in the other the first sub-epidermal layer is a bit of *Mespilus* tissue. This sub-epidermal layer may divide periclinally to form a number of cell-layers, in one case as many as eight. As lateral branches originate from periclinal divisions in the second sub-epidermal layer, Meyer maintains that no graft-hybrid could maintain itself as such in which the mantle should consist of more than two layers.

* Zeitschr. Ind. Abstamm. Vererb., xiii. (1915) pp. 193–233. See also G. H. Shull, in Bot. Gaz., lx. pp. 323–4.

## CRYPTOGAMS.

### Pteridophyta.

(By A. Gepp, M.A. F.L.S.)

**Phylogeny of the Filicales.***—F. O. Bower, continuing his studies in the phylogeny of the Filicales, publishes an account of *Cheiropleuria bicuspis* Presl. and certain other related ferns. In summing up his results he says:—1. *Cheiropleuria bicuspis* is the only known species of a substantive genus. 2. It shows an uncommon mixture of primitive and advanced characters, by which it takes a place phyletically as a synthetic form. 3. Its characters, external and internal, connect it downwards most clearly with *Dipteris*; and upwards—that is, in the direction of more advanced specialization—with *Platycerium*. 4. Its simple hairy investment, protostelic axis, undivided leaf-trace, and its frequently bifurcate form of leaf are relatively primitive characters. 5. Its reticulate venation and its "Acrostichoid" and "mixed" sorus are characters of relative advance. 6. The occasional extension of the receptacular vascular supply of the individual sorus beyond the single vascular areola gives the clue to the state of the sporophyll in *Platycerium*, with its double vascular system in the fertile region. 7. Its slightly oblique annulus, four-rowed sporangial stalk, and alternate segmentation of the primordium form a peculiar link with *Dipteris*, which is shared also by *Metaxya*. 8. The mixed characters which this fern shows supply one of the clearest examples of non-parallelism in progression in the several criteria used for comparison among ferns. 9. The outcome of its comparative examination is to strengthen the relation of *Dipteris* and *Matonia* to some Gleicheniaceous source. 10. It shows that probably *Platycerium* is also a Dipterid derivative, specialized for an epiphytic habit. 11. Probably other Dipterid derivatives will also be found on detailed study, in such forms as *Leptochilus*, *Neocheiropteris*, and some others. 12. Thus the representation of Matonioid-Dipterid derivatives among living ferns appears to be more extensive than had been hitherto appreciated.

**Rachiopteris cylindrica.†**—N. Bancroft publishes a contribution to our knowledge of *Rachiopteris cylindrica* Will., with the following summary:—1. The species is restricted to the Halifax Hard Bed of Lower Coal Measure Age. 2. The stems and petioles may be referred to two types, described respectively as $\alpha$ and $\beta$. (i.) $\alpha$ stems have a well-developed xylem strand tending to mesarch structure, with differentiation of the central elements; the inner and middle cortical areas have fairly thick-walled cells, while the outer cortex is composed of a few layers of thin-walled cells, suggestive of an assimilatory tissue. $\alpha$ petioles also have well-developed xylem strands, frequently with distinct diarch structure; their cortex is like that of $\alpha$ stems. (ii.) $\beta$ stems possess only a small monarch, centrarch xylem strand.

* Ann. Bot., xxix. (1915) pp. 495–529 (2 pls. and figs.).
† Ann. Bot., xxix. (1915) pp. 531–65 (2 pls. and figs.).

The cortex is wide, and composed of thin-walled cells; the middle area is more or less lacunar, and the outer layers of the stem seem to be of the same nature as those of $\alpha$ stems. The corresponding petioles have also a wide cortex, and a reduced xylem strand which is always monarch. 3. These differences of structure probably throw some light on the autecology of *Rachiopteris cylindrica*, presumably an amphibious species, the $\alpha$ and $\beta$ plants being respectively its land and water ecads. 4. *R. cylindrica* seems to be closely allied to *Botryopteris antiqua*, *B. ramosa*, and *B. hirsuta*. So far as the foliar trace is concerned, the four species form a progressive series from the relatively primitive *B. antiqua* to the tridentate types, *R. cylindrica* representing an intermediate term. *B. forensis* does not appear to be very nearly related to this group of British species. 5. Typical steles of *R. cylindrica* show some divergence from the primitive condition, whether this is considered to be an endarch or an exarch protostele, or an asterostele. 6. The method of separation of the foliar trace in *R. cylindrica* affords support to the view that stem and leaf represent homologous branches of a primitively undifferentiated system.

**Leaf-arrangement in Branched Tree-ferns.***—J. C. Schoute continues his studies on the arrangement of leaves in a paper on branched tree-ferns and the branching of Pteropsida in general. The principal points are as follows. In one and the same fern-stem, the leaf scars in the upper portions are in actual contact, while in the lower portions they are widely separated. The separated scars are somewhat oval; those which touch each other are flattened at the point of contact. If a leaf has become abortive owing to pressure, the neighbouring leaves stretch their points of insertion over the vacant place, and thus lose their symmetry. The author sees in this fact the unimportance of the so-called contact for the position of the leaf, and for the development of the leaves from a central position; further, that the leaf-position is not dependent on the form of insertion of the leaves, nor vice versa. In those dichotomies, where the termination of the tissue is incompletely developed in the saddle of the dichotomy, there are found leaves which do not lie as usual at the point of crossing of two parastichs, but only on one parastich. From this the author concludes that the parastichs exercise no determining influence on the position of the leaves. The leaf-traces of these leaves with special position run separately down in the stem, and end, at any rate in part, without connexion with the remaining vascular masses. This observation and those of Hugo de Vries and Nestler on ring-fasciation are important, because they insist on the basipetal arrangement of the leaf-traces, a necessary part of the argument here developed by the author. Detailed observations are given in this paper on the branching, a subject nearly related to leaf arrangement. In two of the specimens examined there were transitions between dichotomy and lateral branching; these transitions were such that of the two forks of the dichotomy one became always weaker, till at last the weaker branch stood by the angle-leaf on the main stem, and the

* Rec. Trav. Bot. Néerl., xi. (1914) pp. 94–193 (17 pls. and 17 figs.). See also Bot. Centralbl., cxxix. (1915) pp. 165–6.

other branch continued the axis. These observations lead the author to bring together from literature all the various accounts of the mode of branching of the Pteropsida; and this enables him to show that the mode of branching of all Pteropsida rests at bottom on the same principle, and that angle-leaf and subtending leaf are homologous.

**Pteridium aquilinum.***—M. Büsgen writes on some peculiarities of *Pteridium aquilinum*. He has made an examination of the structures on the back of the leaf-stalk, which are considered by Hofmeister to be buds of foliar origin, as well as the mode of branching of this species. Shoot and leaf-stalk are easily distinguished anatomically from one another, by an inspection of the figures sketched out in rough brown-walled cells on the transverse section. In the leaf-stalk is the figure of an eagle, in the main stem an oval figure. The author has made a series of successive sections through the leaf-stalk, from its junction with the main stem and the bud on the back of the stalk; and he finds that the apparent leaf-stalk base is in reality a lateral branch of the main stem, which has been hindered in its development by the more vigorous growth of the leaf, and consequently appears to be an appendage of the strongly developed leaf-stalk. The power of growth at the tip of this nob-like lateral branch has not, however, ceased. It is able to produce short shoots richly covered with leaves. These branches arise by a forking of the apex. One of the forks is hindered in its development by the growth of the leaf and so forms a short branchlet.

The author describes the development of a frond up to a height of 3 m., and the anatomy of the rhizome of *Pteridium*, on which are noticeable to the naked eye two opposite light brown stripes, resembling the lenticels of the higher plants. The rhizome of *P. aquilinum* has been used for food in New Zealand and the Canary Islands on account of its richness in starch. The author suggests that in case of hard times in Europe it might be used as food for pigs.

**Bornean Ferns.**†—E. B. Copeland publishes some notes on Bornean ferns, with descriptions of four new species, critical notes on five others, and figures of *Angiopteris Brooksii*.

## Bryophyta.

(By A. Gepp.)

**Œcogenesis of Liverworts.**‡—K. Kavina writes on the œcogenesis of the Liverworts. He says that they show such a wide power of adaptation that it is very difficult to determine the systematic worth of this or that plant. Geological substratum and moisture of the ground and air play a part in the œcogenesis. The species of *Pellia* have certainly arisen through differences of their substratum. In damp air luxuriant

* Zeitschr. Forst. u. Jagdwesen, xlvii. (1915), pp. 235–41 (figs.). See also Bot. Centralbl., cxxix. (1915) p. 496.

† Philippine Journ. Sci. (Bot.) x. (1915) pp. 145–9 (1 pl.).

‡ Vestnik v. sjez. ces. prir. (1915) p. 335. See also Bot. Centralbl., cxxix. (1915) p. 388.

forms are grown, in drier climates depauperate forms. For instance, *Riccia glauca* can be changed in six weeks to a form extremely like *R. fluitans*, while *R. bifurca* kept in a dark damp chamber can in a week become the Warnstorf "species" *R. subscripula*. The author is cultivating a great number of such forms, which are generally regarded as species.

**Distribution of certain Liverworts of the Malay Region.***—D. H. Campbell publishes the results of his own investigations on this subject, and adds to these the observations of others. The following are the main points:—Ricciaceæ are only poorly represented in the Malay district (six species); three are from Java, one also from Amboina, while one, *R. canaliculata*, is cosmopolitan. Targioniaceæ are represented by one species, *T. dioica* Schiffn.: *Cyathodium* is widely distributed through all Malaya (three species), also *Fimbriaria*. *Marchantia* is often found in large quantities, the commonest species being *M. emarginata* and *M. geminata*; *M. polymorpha* seems to be absent from the region, although it has been given as occurring there. *Plagiochasma* is represented by only one species, *P. appendiculata*, from Manila. *Dumortiera* is characteristic for the region. *D. trichocephala* extends as far as Hawaii: it even occurs on Mt. Mattang, in Sarawak, at a height of 600 m. in some quantity, but only in a very limited space, and nowhere around. Two other species of *Dumortiera* are found. *Wiesnerella denudata* (= *W. Javanica* Schiffn.) extends to Japan and Hawaii. *Metzgeria* and *Aneura* are widely distributed in the tropics. The large species *A. maxima* and *A. gigantea* occur in the region. *Podomitrium* has one species in Sarawak and Luzon; and *Pallavicinia* is well represented. The author found also a species of *Symphyogyna*. *Calycularia* species are commoner in the district than is supposed. *Makinoa* and *Treubia* are poorly represented. *Calobryum Blumii* was found in Western Sumatra and New Guinea. The regions richest in liverworts are indicated.

**Three critical Scandinavian Liverworts.**†—H. W. Arnell and C. Jensen have made careful examination of original specimens of the liverworts here discussed, and come to the following conclusions:—*Martinellia squarrosula* Lindb. (*Scapania squarrosula* Lindb., 1852) is only a very impoverished submersed form of *M. purpurascens*. C. Jensen collected a similar submersed form at Gribsö, on Sjaelland, as well as all stages between this form and almost typical *M. purpurascens*, which grew on stones above the water.

*Cephalozia affinis* Lindb., 1882, is, as K. Müller has already discovered, an excellent species whose nearest ally is *C. media*. The authors correct the hitherto accepted descriptions. The lowest portion of the perianth is composed of two strata, and the cilia at the mouth of the perianth are shorter than as figured by K. Müller. *Riccardia fuscovirens* Lindb., 1878, is degraded to a variety of *R. pinguis*, since the characteristics

* Jahrb. wiss. Bot. Pfeffer-Festband., lvi. (1915) pp. 365–73. See also Bot. Centralbl., cxxix. (1915) p. 579.

† Bot. Notiser, 1915, pp. 179–90 (figs.). See also Bot. Centralbl., cxxix. (1915) p. 671.

emphasized by Lindberg are all variable, and not even constantly combined. The characteristics are the thick thallus, the scaly calyptra, and the elaters with broader, laxly twisted spirals.

**Branching of Moss-plants** *—K. Kavina has studied in detail the branching of the Muscineæ, and finds that the gametophyte and anaphyte show a quite analogous branching of the axis. The mode of branching is most clearly to be followed in the foliose mosses and liverworts. In the latter it is mostly dichotomous, in the former it is without exception monopodial. The author points out the difficulties of the investigation: the small size of the objects, the congested leaves, cohesion of the subtending leaves, torsion of the stem, plagiotropic flattening of the whole plant, etc. Finally, he concludes that the liverworts are older than the mosses (liverworts being dichotomous, mosses monopodial); and the genus *Sphagnum*, which also branches dichotomously, represents an isolated very old intermediate type.

**Mosses in Stomach of a Mammoth.**†—F. Camus publishes a note on three mosses—*Polytrichum sexangulare*, *Hypnum revolvens*, *H. stellatum*—found in the stomach of a frozen Mammoth discovered in the Liakhov Islands on the north coast of Siberia. Mixed in with a mass of unrecognisable semi-digested grasses, etc., these mosses, though fragmentary, were identified by their cell-structure. They indicate a very cold climate.

**Ceylonese Mosses.**‡—H. N. Dixon gives an account of a collection of mosses made in Ceylon by C. H. Binstead in February and March of 1913. Some 200 species are comprised; and ten of these and two varieties are described as new to science, and their structure is figured. This, taken with T. Herzog's "Beiträge zur Laubmoosflora von Ceylon," § provides the most complete report yet published upon the moss-flora of Ceylon.

**Mosses of Upper Bavaria.**‖—A. Hammerschmid publishes an addition to the Moss-flora of Upper Bavaria, including in it a list of species from the neighbourhood of the Schliersee, Tegernsee, Tölz, Walchensee, and Kochelsee. *Pleuridium nitidum* is recorded on lake mud at a height of 1300 m., *Tortula papillosa* at 655 m. The description of *Thuidium abietinum* given by Limpricht is amended, the length of the leaves being given as considerably larger. *Drepanocladus Kneiffii*, a species of the plains, is recorded at 1080 m. Rare species of the district are *Cinclidium stygium*, *Cratoneuron decipiens* (which is widely distributed in the district), *Calliergon turgescens*, and *Stereodon pratensis*.

* Vestnik v. sjez. ces. prir. (1915) p. 352. See also Bot. Centralbl., cxxix. (1915) p. 388.
† Comptes Rendus, clx. (1915) pp. 842–3.
‡ Journ. Bot. liii. (1915) pp. 257–67, 289–97.
§ Hedwigia, l. (1910) pp. 115–45.
‖ Mitt. Bayer. Bot. Gesell., iii. (1915) pp. 216–221. See also Bot. Centralbl., cxxix. (1915) p. 420.

## Thallophyta.

### Algæ.

(By Mrs. E. S. Gepp.)

**Growth and Scissiparity among the Peridinieæ.***—Pavillard has come to the conclusion, after a study of the Peridinieæ, that there exists no authentic secondary growth among the symmetric species. The formation of intercalary zones is a morphological preparation for cellular division. Cellular division re-establishes the normal specific type, of which the megacytic individuals, predestined to scissiparity, represent a deviation. The general aspect of the phenomenon offers a curious analogy to the auxosporulation of Diatoms. But the author does not consider that this renders very close the affinity between Peridinieæ and Diatoms. *Phalachroma rastum*, found and figured by Schütt in a state of division, represents the megacytic form of a species, the normal organization of which corresponds to the soi-distant var. *acuta* of the same author. *Phalachroma Rudgei* Murr. & Whit., furnished with broad flat suture-plates, evidently constitutes the megacytic condition of a species, of which the specific type remains unknown.

**Eye-spot of Algæ and Flagellatæ.**†—W. Rothert, who has studied the chromoplast of higher plants, has come to the conclusion that the eye-spot of algæ and flagellatæ is nothing more than a chromoplast. One is then dealing with an independent plasmic organ, which increases always by division into two, and contains in a colourless stroma yellow and red drops. The red and yellow colouring matter belongs to the group of carotins, and is characterized by staining blue with sulphuric acid. Certain facts which appear to conflict with the author's conclusion can be explained satisfactorily. The chromoplasts of the Volvocineæ offer the greatest difficulties, since they are said to arise straight from the cytoplasm. The whole question is, however, still unproved.

**Plankton of the Lietzensee.**‡—E. Kolkwitz writes on the causes of the plankton development in the Lietzensee, near Charlottenberg. Various alterations, dredging, embankment, etc., caused a production of single-formed plankton, consisting in the warm seasons of the year of *Oscillatoria Agardhii*, in the cold seasons of *Stephanodiscus Hantzschianus* var. *pusilla*. Both occurred in large quantities, especially *O. Agardhii*. The alternation of these two species has remained constant for seven years. On the bottom of the lake was formed a plentiful foul mud, which smelt in places like tar and petroleum. Large quantities of the plankton sank to the bottom and added to the mud. From the sulphur of the sinking *Oscillatoriæ* was formed sulphuretted hydrogen.

* Comptes Rendus, clx. (1915) pp. 372–5. See also Bot. Centralbl., cxxix. (1915), p. 5.

† Ber. Deutsch. Bot. Gesell., xxxii. (1914) pp. 91–6. See also Bot. Centralbl. cxxix. (1915) p. 440.

‡ Ber. Deutsch. Bot. Gesell., xxxii. (1914) pp. 639–66. See also Bot. Centralbl., cxxix. (1915) p. 465–6.

A comparison of various lakes has proved that mineral constituents of the water have no noticeable influence on the production of plankton, but the development of "water bloom" goes certainly hand-in-hand with the presence of organic substances washed out from the mud. The lake water was often changed by the running in of fresh water, but this only produced a diminution of the quantity, not the quality, of the plankton. Animal enemies of the algæ appeared to be absent. Details are given of the analysis of the water and mud.

**Marine Plankton.***—G. Stiasny embodies in book form his own knowledge, gained by a study of Adriatic plankton, together with the latest information on the subject in general. The treatment is as follows: History of plankton investigation, conditions of life of marine plankton, organisms (both plant and animal), comparison of fresh-water and marine plankton, methods of investigation, phenomena of adaptation, methods of life, animals and plants in their respective relations, horizontal, vertical and geographical distribution, variations, density of plankton-swarms, plankton-streaming, bipolarity, rôle of plankton in marine economy, importance for mankind, and practical hints for the study and observation of plankton on sea-voyages.

**Colonies of Bacillariaceæ.**†—G. Funk discusses the movements of colonies of Bacillariaceæ and their dependence on outward stimuli. The colonies of *Bacillaria paradoxa* and *Homoiocladia Martiana* take on resting stages under certain conditions; and in these states the individuals are separated as much as possible. As a result of mechanical stimulus the separate individuals of a *Bacillaria* colony slide past each other and change the form of the colony from rows to that of a ribbon, while a colony of *Homoiocladia* shortens itself by a half to a third of its original length. After a short period in the new form they change back to the original resting shape. The colonies of *Bacillaria* take preferably during the day long stretched-out positions, during the night contracted positions. The author notices that in *Homoiocladia* single individuals, in *Bacillaria* single colonies, carry out apparently autonomous movements. The author was unable to establish proof of any reaction to mechanical stimuli in *Schizonema* and *Berkeleya*; he only found autonomous movements.

**Isolation of Algæ from Collemaceæ.**‡—V. Uhlir has succeeded in cultivating Nostocaceæ from the lichen genus *Collema*, in silicic acid lighted by electric light. The cultures grew quickly and luxuriantly. The two points which the author emphasizes are the lighting by electricity and the poverty of the nutritive medium. The algæ need only a certain amount of dampness, which can be obtained by evaporating water under the bell-jar.

* Sammlung Göschen., No. 675. G. J. Göschen's Verlagshandl. (1913) 160 pp., 83 figs. See also Bot. Centralbl., cxxix. (1915) pp. 407–8.

† Mitt. Zool. Stat. Neapel, 1914, Berlin, 15 pp. (1 pl.). See also Bot. Centralbl., cxxix. (1915) p. 4.

‡ Ziva. Praze, 1914–[1915] p. 233. See also Bot. Centralbl., cxxix. (1915) p. 379.

**Lime-dissolving Algæ.***—E. Bachmann has examined a quantity of limestone deposits at Planen, near Meiringen, on the north shore of the Walensee, and in Austrian Croatia, all of which are washed with flowing water. On this limestone he finds a series of Cyanophyceæ which are remarkable for their power of dissolving lime. At Planen the algæ are mostly overgrown with epi- and endolithic lime-lichens. But there are also many patches, 1 sq. m. in size, strewn with small black dots, consisting of colonies of *Glœocapsa*. Each colony inhabits the lower end of a funnel-shaped cavity, while the upper end serves as a water reservoir. In contrast to the lime-lichens, the rock-dwelling Schizophyceæ work downwards rather than horizontally. The dissolving of the lime cannot, as Nadson believes, take place through excretion of lime oxalate, because in that case the origin of the cavities could not be explained. The author considers it more probable that the algæ secrete an acid, which forms a soluble salt with lime. This is then at once washed away by the water. Thus an equivalent quantity of $CO^2$ is set free, which combines with the neutral calcium carbonate to form a bicarbonate which is soluble in water; and so the work of solution continues. In the locality near Meiringen the following species were found:—*Glœocapsa atrata*, *Scytonema myochrous*, *Pentalonema crustaceum*, *Foreliella perforans*, and *Gongrosira codiofolia* At the Tobelschlucht were found *Chroococcus* sp., *Aphanothece caldariorum* (?), in addition to those already enumerated. These algæ dissolve the lime better than the algæ of the Planen limestone. The algal limestone is distinguished from the lichen limestone by its greater degree of porosity. The algæ are therefore remarkable for possessing a greater power of dissolving the matrix than the lichens are.

**Algal Vegetation on the Rock Walls of the Elbe Sandstone Mountains.**†—B. Schorler describes the algal vegetation on the moist rocks of Saxon Switzerland, and the ecological factors bearing on it. The subject is discussed from the points of view of plant geography, distribution of species, and the causes of it. The following associations are examined: Stephanosphæretum, Cladophoretum, Bacillariacetum, Chromulinetum, Glœocapsetum, Glœocystetum, Mesotænietum, and Pleurococcetum.

**Bavarian Fresh-water Algæ.**‡—P. E. Kaiser publishes an addition to his first list of the algæ of the Traunstein and the Chiemgau. The number of species and varieties is now 108. No new species are described, but critical notes are appended to the enumeration of the diatoms.

**Gonium.**§—R. A. Harper writes on the structure and development of the colony in *Gonium*. His paper is primarily a study of the space

* Ber. Deutsch. Bot. Gesell., xxxiii. (1915) pp. 45–57 (1 pl.). See also Bot. Centralb., cxxix. (1915) p. 492.

† Abh. Natw. Ges. Isis, Dresden (1914) pp. 3–27. See also Bot. Centralbl., cxxix. (1915) p. 466.

‡ Mitt. Bayr. Bot. Gesell. Erf. Heim. Flora, iii. (1914) pp. 151–9. See also Bot. Centralbl., cxxix. (1915) p. 566.

§ Amer. Micr. Soc. Trans., xxxi. (1912) pp. 65–82 (1 pl. and figs.). See also Bot. Centralbl., cxxix. (1915) p. 407.

relations of the cells in a colony in order to cast light upon the interactions of cells, and their influence in heredity and ontogeny. In general, the colonies consist of sixteen cells, forming a square with truncated corners, somewhat octagonal in outline. It is shown that the eight cells making the corners of the square are in contact each with three cells, the middle cell of each is in contact with four, and each of the four interior cells is in contact with six cells—thus the series of curves described by Cohn are brought about. It is fundamental that the successive planes of division intersect at right angles. The colony organization, in short, corresponds to the type of division involved in the formation of the cells. It follows that the colony form is not dominant in determining the division planes in new colony formation; that is, "cellular organization" is important, and not heredity of form for the whole organism. Undoubtedly the readjustments in the positions of the cells with the growth of the colony are towards stability and compactness. That the colonies are under considerable pressures as between the different parts is shown by their behaviour. Regeneration of injured cells does not occur.

**Concretions formed by Algæ.***—H. J. Roddy writes on concretions in streams formed by the agency of Blue-green algæ and related plants. He describes concretionary formations occurring in Little Conestoga Creek, Lancaster County, Pa., U.S.A. He discusses their size, shape, composition, hardness, structure and origin; and gives evidences that the active agents of these concretionary formations are Blue-green algæ. Species of the genera *Gleocapsa*, *Gleothece*, *Aphanocapsa*, *Nostoc*, *Oscillatoria*, and *Rivularia* have been identified. Associated with these are several of the Chlorophyceæ. Many species of the Diatomaceæ and Desmidiaceæ which generally live in close association with Cyanophyceæ have also been identified, and have, no doubt, contributed the siliceous matter which is disseminated through the calcareous matrix. Species of *Navicula* are prominent. The author was successful in finding a still greater abundance of concretionary formations in Donegal Creek, Lancaster County. The species associated with them include *Microcystis*, *Cœlosphærium*, and *Chroococcus*, besides most of those already mentioned above. There are also species of *Protococcus*, Diatoms, Desmids, Chlorophyceæ, Phæophyceæ, and Rhodophyceæ.

**Bohemian Characeæ.**†—J. Wilhelm writes on the Characeæ of Bohemia. Of the fifty to sixty European species, the author records twenty-four for that country, of which three are new to Bohemia and three are new species. Many new forms and varieties are also described. Fear is expressed that, owing to the extensive draining and cultivation of the land, many species will be permanently lost.

**The Characeæ of France.**‡—F. Hy publishes an additional note on the Characeæ of France, in which he mentions a great number of

* Proc. Amer. Philosoph. Soc. Philadelphia, liv. (1915) pp. 246–58 (figs.).

† Vestnik v. sjez. ces. prir. (1915) p. 333. See also Bot. Centralbl., cxxix. (1915) p. 379.

‡ Bull. Soc. Bot. France, lxi. (1914) pp. 235–41. See also Bot. Centralbl., cxxix. (1915) p. 62.

localities, which add more exact knowledge concerning the distribution of the group in France. He further discusses *Nitella confervacea* and *Chara vulgaris*, grouping their different forms according to more precise morphological characters, and describing new ones.

**Marine Flora of Tatihou and St. Vaast-la-Hougue.*** —P. Hariot records three new species for this region, *Cordylecladia erecta*, *Phyllophora Traillii*, *Erythrotrichia Welwitschii*, and at the same time notes the disappearance of certain other species. The station of Tatihou lends itself to the study of the development of certain algæ; notably, *Chorda filum*, *Padina pavonia*, colonies of *Schizonema*, etc. The author adds interesting observations on the growth of *Fucus*.

**Alternation of Generations.**†—J. Bonnet writes on the sexual reproduction and the alternation of generations in algæ, and gives a full summary of all that is known on the subject. He argues that since the algæ are a more or less chaotic group, is it not wise to attempt to bring order into the chaos by following the guiding line of alternation of generations?

## Fungi.

(By A. Lorrain Smith, F.L.S.)

**The Ferax Group of Saprolegnia.**‡—A. J. Pieters has cultivated a large series of forms of this group, all of which were considered by Pringsheim to be varying forms of one species. His results have led him to conclude that there are a number of species represented, all closely related, but with distinct characters that persist through many culture generations. Of these *S. monoica* has the most complete sexuality: *S. mixta* less so, with a more delicate mycelium: while in *S. ferax* the loss of sexuality has gone further than in the two former species.

**New Species of Empusa.**§—B. Majmone found the new fungus *E. elegans* on *Porthesia chrysorrhœa*. It differs from *E. muscæ* in the shorter conidiophores, and the very large chlamydospores which are developed within the larval body. Inoculation of living larvæ failed, as did cultures on substrata formed of cooked specimens. Evidently only mummified larvæ are attacked, and to that extent the fungus is saprophytic.

**Study of Tarichium.**‖—This fungus, one of the Entomophthoreæ, now studied by G. Lakon, probably is a stage in the development of

* Comptes Rendus, clix. (1914) pp. 689–92. See also Bot. Centralbl., cxxix. (1915) p. 62.

† Progr. Rei. Bot., v. (1914) pp. 1–128 (figs.). See also Bot. Centralbl., cxxix. (1915) pp. 439–40.

‡ Mycologia, vii. (1915) pp. 307–14 (1 pl.).

§ Centralbl. Bakt., xl. (1914) pp. 98–109. See also Bot. Centralbl., cxxix. (1915) p. 644.

‖ Zeitschr. Pflanzenkr., xxv. (1915) pp. 257–72 (8 figs.).

*Empusa* or *Entomophthora*, but as the conidial fructification is unknown, that point cannot be decided. The mycelium of the fungus consists of spirally twisted, mostly non-septate hyphæ. The resting spores, which are the only fructification noted, arise at the tips of the hyphæ, and swell to a much thicker size; they are yellowish in colour. It inhabits flies under leaves.

Lakon describes and criticizes the different species of this as well as of neighbouring genera. He also considers the question of utilizing the fungus as a means of infecting and so reducing the number of flies, but he does not think that on the whole it is of much practical value as an exterminating disease.

**Systematic Position of Endogone.***—K. Kavina discusses the varying opinions as to the significance of the ampullæ which are a feature of this fungus. Buchholz held that they arose through copulation of the heterogamous ends of hyphæ, but Kavina could find no trace of such a copulation. He considers them rather to be sporangia somewhat similar to those of the Mucoraceæ. He therefore places *Endogone* among the Phycomycetes as an independent family Endogonaceæ.

**Biology of the Oak Mildew.†**—Roth has found that this mildew grows more freely in full sunlight than in the shade, and he thinks this is due to the effect of light on the fungus, and not to the formation by the host-plant of more luxurious shoots or of leaves turgid with sap. He thinks that to some extent the mildew might be checked by shade, though that would delay the growth of the young oaks. Advice is given as to sulphuring attacked trees.

**Infection and Immunity Studies on the Apple and Pear Scale Fungi.‡**—S. P. Wiltshire has studied infection by the two fungi *Venturia inæqualis* and *V. pirina* in the conidial stage. The conidia of the former produces a terminal germ-tube, in the other the tube is lateral: in both a "collar" or flange arises at the apex of the germinating hypha, apparently as an excretion, and it serves to attach it to the cuticle of the host. From beneath the flange a hypha is produced which pierces the cuticle of old leaves, and even of resistant varieties, though only in young leaves of susceptible plants is there any further development: in these a mycelium is formed between the cuticle and the epidermal cells. Immunity, the author concludes, does not depend on protection by the cuticle, nor does chemotropism play any part, as the hyphæ run horizontally: he thinks that, on the contrary, the cell sap of the host may even be antagonistic to the fungus.

* Vestnik v. sjez. ces. prir. (1915) p. 347. (Bohemian.) See also Bot. Centralbl., cxxix. (1915) p. 381.

† Naturw. Forst. Landw., xiii. (1915) pp. 260–70. See also Bot. Centralb., cxxix. (1915) p. 443.

‡ Ann. Appl. Biol., i. (1915) pp. 335–49. See also Bot. Centralbl., cxxix. (1915) pp. 570–1.

**Development of the Perithecia of Venturia inæqualis.***—K. Killian has traced the formation and development of the sexual organs in this Ascomycete, which develops on fallen leaves attacked by *Fusicladium dendriticum*. A spiral hypha arises as a side branch and increases, the inner cells of the spiral being more voluminous, the outer more elongate, the inner cells becoming ascogonial cells. The end cell grows to a great length and functions as the trichogyne. The antheridia arise from neighbouring vegetative hyphæ in the form of finger-like growths which surround the trichogyne. From the latter are formed processes which press against the cells of the antheridium, the intervening membrane becomes sieve-like and the nuclei of the antheridium enter the ascogonial cells.

**Study of Hypocreaceæ.**†—J. Weese has made a critical study of genera and species as at present recognized. He dismisses the genus *Letendræa*, which is distinguished from *Nectria* by the brown colour of the spores, and he does not recognize spore colour as a generic character. In *Nectria* itself he objects to the consideration allowed to the presence of a stroma or subiculum, nor does he think that hairs on the perithecium are a character of any systematic significance. The only constant feature is, he considers, the form of the perithecial wall. Weese describes some new species of *Nectria*, but he sinks *N. Ribis* and *N. guaranitica*.

**Drepanoconis and Clinoconidium.**‡—A. Maublanc has studied these genera and finds that they are closely related in structure and life-history. They induce gall formations on their host-plants, and have been classified by the author under Melanconiæ. With these two genera he associates *Coniodictyum*, parasitic on Rhamnaceæ in S. Africa. The other members of the group are S. American and grow on a species of Lauraceæ.

**Endoconidia of Thielavia basicola Zopf.**§—W. B. Brierley discusses the formation of endoconidia, especially in the above fungus, of which he has made a thorough study. The conidia in this case are not endospores formed by free cell-division within a cell; they are acrogenously abjointed from the conidiophore. The latter is slightly bulbous in its basal portion and possesses an elongated tapering, or almost linear, apical region. Large vacuoles are usually present and not infrequently contain oil-drops. The nucleus lies in the basal portion of the cell.

The first conidium is liberated by the differentiation of its walls into an inner wall and an outer persistent sheath which bursts at the apex.

* Ber. Deutsch. Bot. Gesell., xxxiii. (1915) pp. 164–8. See also Bot. Centralbl., cxxix. (1915) pp. 440–1.

† Centralbl. Bakt., xlii. (1914) pp. 587–613. See also Bot. Centralbl., cxxix. (1915) p. 442.

‡ Bull. Soc. Mycol. France, xxx. (1915) pp. 441–9 (2 pls.).

§ Ann. Bot., xxix. (1915) pp. 483–93 (1 pl. and 1 fig.).

Later conidia, formed further back, grow out through the sheath of the first, the separating wall splitting to allow the passage. These transverse walls arise by ingrowth of the cell-wall substance, which finally meets in the centre and becomes completely closed; they always arise between the vacuoles. Brierley considers that all endoconidia in fungi probably are formed in the same manner.

**Verrucaster lichenicola.***—Tobler describes this new genus and species of Sphæropsideæ which he found growing on the podetium of *Cladonia bacillaris* below the apothecia. The mycelium of the fungus was entirely identical with that of *Cladonia*. The pycnidia are wart-like, the sporophores branched, and the spores minute and colourless. The specimen of the host *Cladonia* was collected by Sandstede at Oldenburg.

**Uredineæ.**—W. H. Long† writes on the influence exerted by the host-plant on the morphological character of rusts. *Puccinia Ellisiana* has two widely separated hosts, *Viola* and *Pentstemon*. When the rust grows on the latter host it assumes the character of another parasite, *P. Andropogonis*. *Viola* is sometimes attacked also by *P. Andropogonis*, which in that case assumes certain characters of *P. Ellisiana*. The author is of opinion that *P. Andropogonis* may possibly have originated from *P. Ellisiana*.

L. Linsbauer‡ records his experience of *Puccinia Pruni-spinosæ*, which seems to winter on the branches, and the *Prunus* species when attacked do not seem to suffer much damage. It does no harm to neighbouring apricots, and the conclusion is that there are two biological races: the one parasitic only on damson and wild plum, the other on peach, apricot and almond. There is also great difference in the susceptibility of the various trees. Damsons suffer most.

**Fungi in an Iron Mine.**§—A. Sartory describes a vigorous growth of fungi that grew in a mine on iron itself. The pilei of the fungus were much deformed, but careful examination of the tissues enabled Sartory to identify the species as *Coprinus atramentarius*.

**Fungi of East Dorset.**‖—E. F. Linton has just published a list of fungi from this district. The ground is almost entirely of light sandy soil; but chalk occurs in Cranbourne and St. Giles, and a strip of heavier soils divides the sandy district from the chalk. The present contribution deals with the Agarics belonging to the *Leucosporæ*, *Rhodosporæ*, *Ochrosporæ* and *Melanosporæ*.

* Abh. Nat. Ver. Bremen, xxi. No. 2 (1913) pp. 383–4. See also Bot. Centralbl., cxxix. (1915) pp. 419–20.

† Journ. Agr. Res., ii. (1914) pp. 303–19. See also Bot. Centralbl., cxxix. (1915) p. 557.

‡ Oesterr. Gartenz., x. No. 9 (1915) pp. 130–2. See also Bot. Centralbl., cxxix. (1915) p. 545.

§ Bull. Soc. Mycol. France., xxx. (1915) pp. 450–1 (1 fig.).

‖ Journ. Bot., liii. (1915) pp. 313–21.

**Italian Fungi.**—L. Maffei * has listed the first century of his "Micologica Ligustica." The fungi were collected along the Mediterranean littoral from Genoa to Albenga. The present contribution takes account only of microfungi, and includes three new species, *Massariella palmarum*, *Ascochyta aquaræ* and *Septoria Eriobotryæ*.

Malusio Turconi † publishes an account of the fungi of Lombardy. These have been to a large extent published in various magazines, and are now gathered together, and the nomenclature given according to modern rules. Those that Turconi has himself collected are printed in darker type. He speaks of the great mycological activity in the Lombardy region during the last twenty years, inspired and directed from the laboratory at Pavia. The species known number 1,970. Bibliography and index are provided.

**New Spanish Fungi.**‡—R. G. Fragoso publishes a series of new records of microfungi in Spain; several of these are new species determined by Bubak or by Fragoso himself.

**New Microfungi.**§—M. N. Naoumoff has described a series of new fungi, parasitic and saprophytic on various plants. A new genus, *Phæocryptopus*, was discovered, similar to *Cryptopus*, but with brown spores. *P. Abietis* grows on living leaves of *Abies sibirica*; the perithecia are superficial on a wide-spreading brown mycelium. A new species, *Rhytisma xylostei*, was found on leaves of *Lonicera Xylosteum*, and proved to be the ascigerous form of *Melasmia Loniceræ*. Another new genus, *Rhizothyrium* (*Pycnothyriaceæ*), has dimidiate pycnidia and elongate three-septate spores.

**Fungi from Porto Rico.**—J. C. Arthur ‖ continues his account of Uredinales based on a collection by F. L. Stevens in Porto Rico, a few species of *Æcidium* and many species of *Uredo*. One of the former genus and many of the latter are described as new species.

Ph. Garman ¶ publishes descriptions and notes on other microfungi also collected by Stevens. They are nearly all new to science and are mostly parasitic on leaves.

**Fungi from the Adirondacks.****—W. A. Murrill lists a number of fungi collected at Upper St. Regis. The number of species collected in a week was over 300. Special attention was given to edible and poisonous fungi, and about thirty-five species were eaten. The fungus flora of that district he found to be distinctly northern, unmixed with southern elements, and associated with coniferous forests. Lists are given of the genera and species, and views of the neighbourhood are reproduced.

* Atti Ist. Bot. Pavia, xii. (1915) pp. 1–16 (1 pl.).
† Atti Ist. Bot. Pavia, xii. (1915) pp. 57–284.
‡ Bol. Hist. Nat., xvi. (1915) pp. 337–43.
§ Bull. Soc. Mycol. France, xxx. (1915) pp. 423–32 (4 pls.).
‖ Mycologia, vii. (1915) pp. 315–32.
¶ Mycologia, vii. (1915) pp. 533–40 (1 pl. and 1 fig.).
** Mycologia, vii. (1915) pp. 297–306.

**Australian and New Zealand Fungi.***—E. M. Wakefield publishes a descriptive list of some fungi that were collected in Australia and New Zealand by W. N. Cheesman, on the occasion of the visit of the British Association. The species belong more or less to the temperate type of fungus flora. Of the 100 species named, forty-eight, or nearly half, occur in Europe or North America, or both. Of these forty-eight, twelve only are cosmopolitan Of the remaining species, twenty-eight are endemic to Australasia, these including seven new species, and five of them have strong affinities with known species of Europe or North America.

**Fungi from New Caledonia.**†—Ed. Fischer writes on the genus *Dictyophora*, one species of which was brought home by the Garasin and Roux Expedition. The species *D. indusiata* is extremely variable, and has been described under different names, but Fischer considers these merely varieties. It is found in the Eastern tropics.

**Plant Diseases.**—Malusio Turconi and Luigi Maffei ‡ report on diseases of plants examined in the cryptogamic laboratory of the University of Pavia. Leaves of *Fraxinus* sent from Mexico were found to be attacked by a spot-hole disease which was caused by a fungus, *Cercospora lumbricoides* sp. n. The hyphæ of the fungus penetrate the internal tissues of the leaf and destroy them.

Another disease, also from Mexico, attacking the branches of *Castilloa elastica*, a caoutchouc plant, was examined. The fungus *Nectria Castilloæ* sp. n. is described at length. The mycelium had thoroughly invaded the tissues, but the writers were unable to determine whether it had caused the death of the branch. On branches of *Morus* from Roustchouk, in Bulgaria, they found *Steganosporium Kosaroffii* sp. n. The fungus was parasitic, but it was impossible owing to scarcity of material to give a proper account of its effect on the host-plant.

A. Paillier § has reported the devastation caused by mildew in the vineyards of S.E. France during the past year. The fungus *Plasmopara viticola* spread in a manner never known before. The reason assigned is the insufficient spraying due to lack of labour, along with the imperfect cultivation of the vineyards: the trouble was also aided by the exceptionally hot, heavy weather. It was reckoned that the six departments of the south of France, which yielded over 500 million gallons of wine in 1914, would in consequence of the disease hardly produce half or even one-third of that amount.

F. Martinotti ‖ records a severe outbreak of the same disease in Piedmont. Weather conditions are chiefly blamed. The leaves were everywhere successfully sprayed, and responded to treatment, but the

* Bull. Roy. Bot. Gard. Kew, 1915, pp. 361–76 (2 pls.).

† Sarasin and Roux, Nova Caledonia, Kreidel, Wiesbaden, 1914, pp. 3, 4.

‡ Atti Bot. Ist. Pavia, xii. (1915) pp. 329–36 (1 pl.).

§ La Vie Agric. Rur., v. No. 9 (1915) p. 159. See also Bull. Agric. Intell. Rome v. (1915) p. 1261.

‖ Giorn. Vin. Ital., xli. (1915) pp. 613–15. See also Bull. Agric. Intell. Rome, v. (1915) p. 1261.

spraying of the bunches of grapes was neglected at the right time with the above disastrous results.

F. L. Stevens * has described three fungi that cause damage to strawberries. Strawberry fruit-rot, due to *Patellinæ* sp. n., is first seen as a minute spot on either green or ripe berries; on the latter it increases with great rapidity, the surface becomes studded with the sporodochia of the fungus, and the whole berry may become involved in about four days.

Strawberry fruit-rot due to *Sphæronemella* sp. n. grows frequently along with the previous fungus. It forms pycnidia all over the surface of the berry, and they are of such a gelatinous texture that the fungus can be detected by feeling the berry. These two fungi have been found repeatedly on market berries.

Strawberry black-rot is due to *Sphæropsis malorum*. The fungus causes a blackening and eventual shrivelling of the berries. It is not nearly so prevalent as the two first described.

A. C. Forbes † records the appearance of *Peridermium strobi* in Ireland on Weymouth Pine (*Pinus Strobus*). The affected trees were only about six years old, and the disease had evidently been introduced from the nursery where they were obtained.

J. R. Webb ‡ found an undescribed fungus, *Herpotrichia quinqueseptata* sp. n., on diseased leaves and twigs of *Picea Engelmanni* from Idaho.

Eugenia Rangel § has described a series of fungi parasitic on the leaves of pigeon-peas (*Cajanus indicus*) in Brazil. On the under-surface he found a new genus which he calls *Velosiella*, provisionally placed in the Stilbaceæ. The mycelium does not spread far from the point of infection, but numerous attacks seriously affect the leaves.

He found also *Cerospora instabilis* sp. n., and in addition *Colletotrichum Cajani* sp. n., *Phillosticta Cajani* sp.n., and *Phorna Cajani* sp. n., the latter on dried fruits.

**Diseases of Brassica Napus var. rapifera.** ‖—J. Eriksson describes two types of injurious organism that attack cabbage-turnips. His attention was first drawn to several misshapen roots with hollows in them which sometimes penetrated deeply into the flesh of the turnip. Occasionally he found a great development of *Fusarium Brassicæ*, or in other parts he detected the presence of bacteriosis due to *Pseudomonas campestris*. It seemed impossible to decide which of these two was the original cause of the trouble. Eriksson gives an account of *Fusarium* attacks, and concludes that the disease was furthered by the damp state of the ground, as other roots in the vicinity, but under more favourable conditions, were healthy.

* Science, n.s. xli. (1915) pp. 912–13. See also Bull. Agric. Intell. Rome, vi. (1915) pp. 1260–1.

† Quart. Journ. Forestry, ix. (1915) pp. 250–1. See also Bull. Agric. Intell. Rome, v. (1915) p. 1262.

‡ Journ. Agric. Research. iv. No. 3 (1915) pp. 251–3 (1 pl.).

§ Boll. Agric. Sao Paulo, ser. 16, No. 2 (1915) pp. 145–561 (3 pls.). See also Bull. Agric. Intell. Rome, vi. (1915) pp. 1120–1.

‖ Zeitschr. Pflanzenkr., xxv. (1915) pp. 65–71 (5 figs.).

He gives also instances of beet (*Beta vulgaris* var. *hortensis*) being attacked by *Fusarium Betæ* and *Phoma Betæ*. The beets were surrounded by a dark ring at the level of the soil, the fungus having gained entrance by cracks in the skin. Large wounds were formed round these centres of infection from ½ to 3 c.m. across, and ½ c.m. deep, and these were filled with the greyish-white mycelium of the *Fusarium*, and later with the black dots of the *Phoma* pycnidia. The two fungi had a disastrous effect on the beet. Eriksson blames the condition of the soil for the attack by the two fungi, and recommends more care in preparing the ground.

**Fatal Cases of Poisoning.***—A. Sartory gives an account of three cases of poisoning due to eating *Amanita phalloides* in mistake for mushrooms. They were eaten in the evening, and bad symptoms did not appear until the next day. One curious effect was that two of the patients seemed to be recovering, then very suddenly succumbed to the poison, though every possible means was taken to counteract the poison.

## Lichens.

(By A. Lorrain Smith, F.L.S.)

**Cetrariæ of the United States and Canada.**†—R. Heber Howe presents a systematic account of this genus represented in the area by six species. Though the hyphal structure of this fruticose genus is radial, the gonidia, which occupy a single stratified layer, link it with dorsiventral genera. One species, *C. Richardsonii*, is confined to Arctic N. America, and is common from Hudson's Bay to Dawson, Yukon, and up to the Arctic Sea.

**Lichens of South Lancashire.**‡ J. A. Wheldon and W. G. Travis have published an exhaustive account of the lichens of this district, with important observations on the nature of the soil, rocks, trees, etc., and especially on the deleterious effect of the smoke from a great industrial district. They give an account of the populations and industries, and contrast previous records with the lichen flora as it exists now, pointing out the influence of the polluted atmosphere on the different types of lichens and in the different localities. The district worked over includes a considerable coast line, and the sand dunes have been examined, their special flora being described. The systematic list includes all previous records, those lichens now extinct being indicated, such as *Lobaria pulmonaria*. Several new species of crustaceous lichens were found, and the diagnoses are given.

**Ecology of Lichens.**§—Ecological notes by the late W. West are now published. His observations deal with mosses and hepatics, though principally with lichens. He noted that lichens grew generally on the

* Bull. Soc. Mycol., France, xxx. (1915) pp. 438–40.
† Torreya, xv. (1915) pp. 214–30 (10 figs.).
‡ Journ. Linn. Soc., xliii (1915) pp. 87–136.
§ Journ. Linn. Soc., xliii (1915) pp. 57–85.

exposed side of trees, the bryophytes on the less exposed. The results have been set forth in tabulated form, and they record the formations and associations of lichens on trees in many parts of the British Isles. West has given the chief corticolous lichens approximately in the following ratio: *Parmelia saxatils* 6, *P. fuliginosa* var. *lætevirens* 2, *Lecanora tartarea* 2, *Platysma glaucum* 1, *Pertusaria globulifera* with *P. faginea* and other species 1. Other species occur in great abundance here and there, *Pyrenula nitida* sometimes almost covering the smooth bark of young trees; *Graphis elegans* taking complete possession of the stems of hollies.

**Lichens of New Caledonia.***—A short series of these have been determined by J. Harmand. Most of them are cosmopolitan species, while others are more distinctly Australian. A new variety, *isidiosa*, of *Pannaria parmelioides* is described, and new varieties of *Ramalina denticulata* and of *Usnea articulata*, the latter variety depending on the reaction with potash. Localities and distribution are given, and there is a fine photograph of the Australian *Cladonia retipora*.

**Lichen Flora of Southern California.**†—H. E. Hasse lists a number of lichens from the hilly regions of California, especially the Santa Monica range. None of them are new species, but many are new to the country. Notes are given with most of the species.

## Schizophyta.

### Schizomycetes.

**Locust Destruction in Morocco.**‡—M. Béguet has conducted a series of successful experiments in 1913 and 1914 on the effects of pulverized cultures of *Coccobacillus acridiorum* (d'Herelle) on infestations by the Moroccan locust, *Stauronotus maroccanus*, in Algiers. The methods employed did not provide an immediate means of protecting the harvests from the depredations of these insects, but according as the locusts were destroyed during the campaign so the chances of successful combat during the following season were increased. Thus during successive campaigns a sensible reduction of the foci of invasion reasonably might be expected. Even where the induced infection did not prove fatal to the insects, a state of morbidity was produced which rendered the animals sluggish and enfeebled, thus becoming a ready prey to the customary methods of locust destruction. By employing insufflations of the coccobacillus the campaign of destruction can be prolonged by over a month, thus covering the egg-laying period. The author concludes that there is a real economic gain in adding this weapon to the approved means of mechanical destruction called for by experience. The biological procedure is not destined to replace these mechanical means, but rather to act as a useful adjuvant.

* Sarasin and Roux, Nova Caledonia Kreidel, Wiesbaden, 1914, pp. 7–15 (1 pl.).
† Bryologist, xviii. (1915) pp. 92–4.
‡ Ann. Inst. Pasteur, xxix. (1915) pp. 520–36.

**Locust Destruction Experiments in the Philippines.***—M. A. Barber and C. R. Jones, experimenting with *Coccobacillus acridiorum* (d'Herelle) in the Philippines, have failed to obtain any results of practical value in relation to locust destruction in the field. The experiments in question were made against mixed swarms of *Œdaleus nigrofasciatus* (De Geer) and *Locusta migratoroides* (R. and F.). With some difficulty they were able to exalt the virulence of the strain of coccobacillus, which they obtained direct from M. d'Herelle, so that death of the acridian followed inoculation in from six to eight hours (the degree of virulence required by the directions), but extended spraying experiments with broth cultures of these exalted organisms failed to produce any appreciable effect on the experimental locust swarms. The authors, moreover, showed that *Bacillus prodigiosus* and another organism ("Singalong") isolated from dead locusts could be similarly exalted in virulence, and give equally good (or bad) results in the field. Barber and Jones suggest "that two conditions may have contributed to make our results less successful than those reported from the Argentine—the species of insects and the prevailing high temperature," but these suggestions do not appear to carry conviction. M. d'Herelle, on the other hand, suggested that the failure was due to "lack of strength of the virulence."

**Diagnosis of Cerebro-spinal Fever.**†—H. Warren Crowe recommends the following medium for the identification of the meningococcus, either from the cerebro-spinal fluid or from the naso-pharynx. It consists of three parts of defibrinated bullock's blood, one part of trypsin agar (Douglas), and 1 p.c. glucose. The medium is mixed at 50° C. in sterile fashion, poured into plates or tubes, and steamed for three successive days at 60° C. for two or three hours, but raised to 80 C. during the last half-hour on the third day. The medium should be dark brown in colour and opaque, and should present a smooth glossy surface. On account of its opacity, the cultures must be examined by reflected and not by transmitted light. The only colonies growing on this medium which resemble meningococci are those of the pseudo-meningococcus and *M. pharyngeus flavus*. The former can be distinguished by agglutination tests, and the latter by pigment production. With regard to the latter, in doubtful cases, the suspected colony should be immersed in N/10 sulphuric acid, with which reagent the meningococcus colonies turn pale blue, while the pigmented colonies are changed to a muddy green colour. The clear-cut edges of the meningococcus are easily observed on this medium by reflected light, while the extreme flatness of the colonies is more readily observed than by transmitted light. The loss of the usual granular appearance is not considered to offset the advantages offered by the new medium.

**New Gas Gangrene Organism.**‡—M. Weinberg and P. Séguin have found associated with *B. œdematis maligni* and *B. œdematiens* a new pathogenic anaerobe which, on account of the difficulty of its

* Philippine Journ. Sci., x. (1915) pp. 163–76.
† Lancet, clxxxix. (1915) pp. 1127–33.
‡ C.R. Soc. Biol. Paris, lxxviii. (1915) pp. 686–9.

identification, is described under the name of *B. fallax*. Morphologically the bacillus resembles *B. œdematis maligni*, but spores are not observed in pathological exudates, nor are they found in glucose or glucose-free media even after several months' incubation. The organism is feebly motile in young cultures, but is actively motile in serous exudates. It possesses numerous flagella (twenty or perhaps more) which are very long, sinuous and spiriliform. *B. fallax* is a strict anaerobe and is an active gas-producer. The cultures, unlike *B. œdematis maligni*, do not possess a putrid odour, but have an acid smell resembling *B. perfringens*. The organism has been found to be pathogenic for the guinea-pig and the mouse, but not for the rat. 1 c.cm. of culture in intravenous injection kills the guinea-pig in ten to sixteen hours; 0·25 c.cm. in twenty to thirty hours. Following subcutaneous inoculation the muscles become hyperæmic, and are infiltrated with bubbles of gas, while a gelatinous œdema extends over the entire abdomen. The visceral lesions resemble those provoked by infection with *B. œdematis maligni*. An agglutinating serum with a titre of $\frac{1}{500}$ has been prepared by subcutaneous injection of rabbits with killed cultures of the bacillus. The serum has no agglutinating action on *B. œdematis maligni*, *B. œdematiens*, or *B. perfringens*, nor is the organism itself agglutinated by antisera homologous with the latter organisms.

**Heterogamic Conjugation observed with a New Yeast: Zygosaccharomyces Nadsonii.***—A. Guilliermond has identified a new species of yeast, *Zygosaccharomyces Nadsonii*, which he has isolated from a decoction of bitter orange peel which showed active fermentation. This new yeast is of peculiar interest as, in common with two previously described genera, *Debaryomyces* and *Nadsonia*, it exhibits true heterogamy. At the moment of conjugation the yeast-cells are rounded in shape, and possess one to three small buds, which are still united to the parent-cell, the conjugation being effected between the parent-cell and one of the buds. The mother-cell plays the part of the female gamete, whilst the bud plays the rôle of the male gamete. The two cells are united by a copulatory canal formed by the fusion of the two extruded processes. The contents of the male gamete emigrate into the female gamete, which then transforms itself into an ascus, generally enclosing two rounded ascospores, whilst the remains of the male gamete is reabsorbed. In some cases the contents of the two gametes mingle *in situ* without the emigration of the male element. In this case the unequal masses are united by a narrow isthmus, each portion containing an ascospore. This phase is a transition between iso- and heterogamy. This method of conjugation differs from that previously described by the author in the case of *Zygosaccharomyces chevalieri*, in which the male-functioning cell is completely separated from the female cell before conjugation.

**Dysentery in the Argonne.**†—P. Remlinger and J. Dumas have investigated a series of cases of dysenteric infection occurring among

* C.R. Soc. Biol. Paris, lxxviii. (1915) pp. 568–70.
† Ann. Inst. Pasteur., xxix. (1915) pp. 498–519.

the allied troops operating in the Argonne from December, 1914, to March, 1915. No case of amœbic or flagellate protozoan dysentery was observed, all the infections noted being bacillary in origin. With regard to fermentation reactions, the majority of the organisms isolated closely resembled the "Bacillus Y" described by Hiss, as can be readily observed from the following table:—

| | Saccharose | Maltose | Mannite |
|---|---|---|---|
| Shiga .. .. .. .. .. .. .. | − | − | − |
| Flexner .. .. .. .. .. .. | + | + | + |
| Strong .. .. .. .. .. .. .. | − | + | + |
| Hiss .. .. .. .. .. .. .. | − | − | + |
| "Bacillus of the Argonne" .. | − | − | + |

The reaction of the two organisms thus agree in the production of acid without gas in mannite, while producing no change in saccharose or maltose.

No agglutination was produced with $\frac{1}{50}$ anti-typhoid, anti-paratyphod A and B, and anti-Shiga sera with a titre of $\frac{1}{4000}$, but agglutination was produced with an "anti-Y" serum in dilutions between $\frac{1}{500}$ and $\frac{1}{4000}$, and with anti-Flexner serum (titre $\frac{1}{2000}$) between $\frac{1}{200}$ and $\frac{1}{4000}$ dilutions. Agglutinations were also observed with the homologous sera derived from the patients themselves. In all, twenty-five strains of this bacillus were isolated. Two strains of an organism giving the sugar reactions of *B. dysenteriæ* (Shiga) were also isolated, but they failed to give any agglutination with a powerful anti-Shiga serum, or with the homologous sera of the patients themselves; they gave, however, a positive complement fixation reaction with the latter sera.

# MICROSCOPY.

## A. Instruments, Accessories, etc.*

### (4) Photomicrography.

**Bagshaw's Elementary Photomicrography.**† — This useful little manual, of which the third edition has just appeared, should be in the hands of every beginner in photomicrography. It is intended to make plain and smooth the part of the inexpert, and, if simplicity of explanation and avoidance of technical terms can accomplish that object, no one who follows its instructions ought to fail. At the same time it is a serious book because it does not shirk difficulties, and because it is enriched with a large number of beautiful half-tone photomicrographs which are calculated to encourage the student to persevere. The author limits himself to the simplest apparatus, and the original prints of the illustrations were all taken with objectives supplied with an ordinary student's Microscope. A bibliography of books useful to those who wish to extend their researches in photomicrography adds to the value of the manual.

## B. Technique.‡

### (1) Collecting Objects, including Culture Processes.

**Hæmoculture in Citrated Broth.**§—The advantages claimed for the Conradi-Kayser method of blood cultures in ox-bile are : (*a*) that the medium dissolves the blood corpuscles ; (*b*) prevents coagulation of the blood : and (*c*) constitutes a very good medium for the growth of typhoid and paratyphoid bacilli. A. Lebœuf, J. Bonafous and P. Braun have substituted for this medium one consisting of citrated broth, which, in addition to being more readily obtainable, is said to give equally good results. The new medium inhibits the coagulation of the blood, and thus eliminates the most adverse factor against the growth of the organisms. 0·5 c.cm. of 10 p.c. citrate of soda solution are added to each 10 c.cm. of pepton broth, the medium being sterilized after the addition of the soda solution. 2 c.cm. of blood from the

* This subdivision contains (1) Stands ; (2) Eye-pieces and Objectives ; (3) Illuminating and other Apparatus ; (4) Photomicrography ; (5) Microscopical Optics and Manipulation ; (6) Miscellaneous.

† Iliffe and Sons, London, 1915, 140 pp. (15 pls. and 20 figs.).

‡ This subdivision contains (1) Collecting Objects, including Culture Processes ; (2) Preparing Objects ; (3) Cutting, including Imbedding and Microtomes ; (4) Staining and Injecting ; (5) Mounting, including slides, preservative fluids, etc. ; (6) Miscellaneous.

§ C.R. Soc. Biol., Paris, lxxviii. (1915), pp. 662-5.

patient's vein are added to 10 c.cm. of the medium, which is then incubated in the usual way. In every case where positive results were obtained in bile culture, comparable results were forthcoming in the citrated broth cultures, the only drawback to the procedure being that there was a delay of about twenty-four hours in diagnosis. In one case this delay amounted to five days, and in another to seven days. The advantages claimed are that the medium is constant in composition, and that it permits the growth of other organisms [e.g. *Micrococcus militensis*] found in septicæmic conditions.

**New Method of Differentiating Bacillus typhosus, Paratyphosus A and Paratyphosus B.***—E. Burnet and R. J. Weissenbach have devised a new method for identification of typhoid and paratyphoid organisms by means of culture on acetate of lead agar. The method is stated to be simple, rapid and certain in its results, which have been fully confirmed by agglutination reactions. To 4 c.cm. of heated agar are added $\frac{1}{20}$ c.cm. of a 10 p.c. fresh sterile solution of neutral acetate of lead in distilled water. After mixing, the agar is allowed to reset, a milky opacity being then observed. The platinum needle charged with the organism to be investigated is insinuated between the side of the test-tube and the column of agar with a slight rubbing motion. Incubation is carried out at 37° C. In the case of *Bacillus paratyphosus B.* a black band appears along the track of the needle at the end of eighteen hours; with *B. typhosus* the band appears later (twenty-four hours) and of a lighter colour. *B. paratyphosus A* does not blacken the medium until after several days' growth. If the inoculation be made direct from a hæmoculture in bile, the traces of blood and bile carried over in the platinum loop must not be confounded with the reaction produced by the disassociation of the lead salt.

**New Medium of Culture of Encapsulated Organisms.†**—H. Carageorgiadès points out that there is a tendency in clinical bacteriology to replace natural albuminous media (ascitic fluid, eggs, etc.), by compounded albuminous media (Besredka's egg-broth, egg-agar, etc.), the preparation of the latter media being easier and the sterilization more certain. Working on these lines, the author has prepared a new medium which, he states, may be employed with advantage as a substitute for the diagnostic medium of Bezançon (young rabbit serum) used for demonstration of capsulated organisms. The new medium is prepared as follows:—

To 66 c.cm. of distilled water are added 30 c.cm. of blood serum of indifferent origin, 10 c.cm. egg-white, 10 drops of neutral glycerin, and 0·5 c.cm. of deci-normal soda solution. Shake the mixture in a 250 c.cm. flask until thoroughly mixed, and autoclave at 115° C. for fifty minutes. Filter warm through Chardin paper. Tube and re-sterilize at 115° C. for ten minutes. The resulting medium is clear, of an amber-yellow colour with opalescent reflections. It keeps well, but, in common

* C.R. Soc. Biol., Paris, lxxviii. (1915), pp. 565–8.
† C.R. Soc. Biol., Paris, lxxviii. (1915), pp. 677–8.

with pure serum and ascetic fluid, at length deposits a whitish powdery sediment. The medium may be solidified by the direct addition of 2 p.c. agar.

**Tetravaccine: Typhoid + Paratyphoid A + Paratyphoid B + Cholera.***—A. Castellani and R. W. Mendelson report very favourably on the results obtained with their tetravaccine in Serbia, where they gave protective inoculations to some 50,000 persons. Each c.cm. of the compound vaccine contained 500 million typhoid organisms, 250 million each of paratyphoid A and B, and 1000 million cholera organisms. 0·5 c.cm. of the vaccine was given subcutaneously, a similar dose being repeated a week later. The inoculations were quite harmless, and protective substances were developed against the four organisms, the amount of agglutinins present being practically the same as in control individuals inoculated with typhoid, paratyphoid A, paratyphoid B, and cholera monovaccines. The authors are of opinion that the tetravaccine should be used as a matter of routine to inoculate the troops taking part in the present war, its use rendering it possible to give by a simple and rapid procedure a contemporaneous protection for the four maladies.

**Examining Fæces for Protozoa.**†—C. M. Wenyon recommends that thin films be used for examining fresh fæces, and in dealing with encysted forms a small drop of Gram's iodine solution should be mixed on a slide with a small quantity of fæces (iodine 1, iodide of potassium 2, distilled water 100). A cover-glass should be imposed and the preparation examined at once. This procedure renders the nuclei quite distinct.

For permanent preparation the following method has given good results. A thin smear of the fæces is made on a cover-glass, and then is dropped without drying, film-side downwards, on to a fixing fluid. A good one consists of 2 parts of aqueous sublimate and 1 of alcohol. The cover-glasses float on the surface of the fixative and are allowed to remain there for 20–30 minutes. They are then removed and placed in a Petri dish of 30 p.c. spirit (this time film-side up) in order to remove the sublimate. After a few minutes' washing in this manner in several changes of the alcohol they are placed in distilled water. They are then stained best with iron hæmatoxylin. The films are left to soak in a 4 p.c. solution of iron alum, they are then rapidly washed in distilled water, and then placed in Heidenhain's hæmatoxylin. After some hours the black films are washed and then immersed in 1 p.c. iron alum solution to differentiate. The differentiation must not be carried too far, and the films must be examined every few minutes in distilled water under one-sixth objective. After proper differentiation the films are dehydrated in alcohol, passed through xylol, and mounted in balsam.

The author remarks that it is essential to have constantly at hand an eye-piece fitted with a micrometer scale, the size of the divisions of which is known in microns for each power of the Microscope and for a definite tube length.

* Brit. Med. Journ. 1915, ii., pp. 711–3.
† Lancet, 1915, pp. 1173–83 (1 pl.).

**New Medium for the Cultivation of Meningococcus.***—H. W. Crowe says that with the following medium it is impossible to miss a positive. It is easily prepared, and keeps well when tubed, though, in common with other media, plates must be fairly fresh. It consists of three parts of defibrinated bullock's blood, one part of trypsin agar (Douglas) with 1 p.c. of glucose. The component parts are mixed in sterile fashion at 50° C., poured into sterile plates or tubes, and steamed for three days in succession at 60° C. for two or three hours, but raised to 80° C. during ths last half-hour on the third day. The medium should be dark brown and opaque, and should present a smooth glossy surface. It should be at least one-eighth to three-sixteenths of an inch in thickness on plates.

### (2) Preparing Objects.

**Simple Device for Controlling the Movements of Paramœcia.**†—R. W. H. Row has found the following procedure give very successful results. A small quantity of ordinary gum is painted on a glass slide and allowed to become nearly dry; a drop of water containing the Paramœcia is then placed on the gum and covered in the ordinary way with a cover-glass. At first the gum will scarcely interfere with the movements of the animals at all, but within a few minutes, as the gum diffuses through the water, they will be seen to move more and more slowly, and ultimately they will be unable to move at all. Finally, the irritation caused by the gum will result in the discharge of the trichocysts. By this method the normal shape and appearance are retained for a long time, even when the animal has become stationary, though the gullet tends gradually to disappear.

### (4) Staining and Injecting.

**Vital-staining of Insects by Means of Soluble Carmin.**‡—A. C. Hollande remarks that when insects are injected with an aqueous solution of a carminate soluble in water, certain cells absorb the carminate in about twelve hours and are stained red. The absorbing cells are the pericardial and the phagocytic leucocytes. The author then by means of the following procedure rendered insoluble carmin soluble. To 1 grm. of acid in a porcelain basin is added powdered carmin in quantity sufficient to neutralize the acid. The mixture is diluted with 100 cm.$^3$ of distilled water. It is then boiled for ten minutes and afterwards filtered, and then volume is brought up to 100 cm$^3$. This solution is used for injection; it is very stable and neutral to litmus. Sulpho-carmin and chloro-carmin are the examples given. The chloro-carmin is quite innocuous in 1 p.c. aqueous solution. After injection not only are the pericardial cells and the phagocytic leucocytes stained red, but also the cells of the Malpighian tubes. After ingestion by the insects it was found that the protoplasm of the foregut was deeply

* Lancet, 1915, ii., pp. 1127–33 (6 figs.).
† Nature, 1915, p. 286.
‡ Comptes Rendus, clxi. (1915), pp. 578–80.

coloured. While the alkaline carminates tend to remain in the cells, the acid-carmin do not tarry long, and are totally eliminated by the Malpighian tubes.

**Method for Quick Detection of Spirochæta pallida.***—W. H. S. Stalkartt recommends the following procedure :—1. Fix in 1 p.c. glacial acetic acid and 8 p.c. formalin ; rough-dry the slide. 2. Wash in alcohol and flame off. 3. Gently heat in 5 p.c. solution of tannic acid. 4. Wash in water and stain with slightly warmed silver nitrate solution. (To a 5 p.c. solution of silver nitrate add ammonia solution until the precipitate first formed is just dissolved ; add a few more drops of silver nitrate solution until the precipitate just reappears.) 5. Wash in distilled water and dry : the films must not be mounted in balsam.

### (6) Miscellaneous.

**Method of Cleansing Living Mussels from Ingested Sewage Bacteria.**†—J. Johnston, working in connexion with the Lancashire Sea Fisheries Laboratory and at the Sea-fish Hatchery at Piel, near Barrow, has conducted an exhaustive investigation in relation to the purification of contaminated Mollusca, and has arrived at certain important conclusions. It was found that the process of self-cleansing of sewage-polluted shell-fish by placing them for some days in clean sea-water depended on (*a*) the ingested bacteria being washed out from the mantle cavity and internal cavities by virtue of the continuous stream of water circulating through these passages ; and (*b*) on the fact that the bacteria rapidly die out of a medium which is unfavourable for their development. The optimum temperature of truly intestinal bacteria is about 37° C., i.e. the temperature of the interior of the bodies of mammals, whilst the temperature of sea-water and the interior of marine molluscs is about from 3° C. to 15° C., and it has been ascertained that fæcal micro-organisms disappear very rapidly when introduced into sea-water—the destruction of some 90 p.c. of the organisms being effected in the first forty-eight hours. In one case the average number of sewage bacteria estimated was 7,400 per shell-fish. The mussels were put into glass aquarium tanks of about 10 litres capacity, and sea-water was run through the tanks at the rate of about one litre per five minutes. Samples of the mussels were taken at intervals of one, two and four days, and it was found that on the second day the average number of bacteria per mussel had fallen to 116—i.e. a reduction of 98·5 p.c.

The same result can be brought about by the addition of chlorine, a concentration of chlorine in sea-water of 5 parts per million being sufficient to sterilize the water, while it does not interfere with the ordinary functioning of the shell-fish. The action of the chlorine is twofold : in the first place, it renders the polluted sea-water practically free from sewage bacteria, and then this sterile water washes out the

* Brit. Med. Journ. 1915, ii., pp. 895-6.
† Proc. and Trans., Liverpool Biol. Soc., xxix. (1914-15), pp. 119-70 (with plates, charts and text figs.).

ingested bacteria from the alimentary canal of the shell-fish: in the second place, it actually destroys the micro-organisms present in the bodies of the shell-fish, but this appears to be a function of subsidiary importance.

It is pointed out that there is urgent need for investigation into the specific nature of the various kinds of micro-organisms present in fæces and in polluted waters and shell-fish, and that the natural history of these organisms demands consideration. The following is a table showing the percentage of "coli-form" organisms found in human fæces and sewage-polluted mussels respectively:—

| MacConkey: Organisms abundant in human fæces. | | Organisms present in shell-fish: mussels. |
|---|---|---|
| *B. neapolitanus* .. .. <br> *B. No.* 71 .. .. .. .. | 30 p.c. .. .. .. .. | 4 p.c. |
| *B. vesiculosus* .. .. <br> *B. grünthal* .. .. .. <br> *B. sulcatus gasoformans* <br> *B. cartellus* .. .. .. | 22 p.c. .. .. .. .. | 24 p.c. |
| *B. coli communis* .. .. <br> *B. cavicida* .. .. .. | 20 p.c. .. .. .. .. | 7 p.c. |
| *B. schafferi* .. .. .. | 6 p.c. .. .. .. .. | — |
| *B. lactis ærogenes* .. .. <br> *B. dysenteriæ* .. .. .. <br> *B. capsulatis* .. .. .. | 4 p.c. .. .. .. .. | 6 p.c. |
| **Organisms rare in human fæces.** | | |
| *B. acidi lacti* .. .. .. | 0·5 p.c. .. .. .. .. | 9 p.c. |
| *B. coscoroba* .. .. .. | 0·5 p.c. .. .. .. .. | 2 p.c. |
| *B. cloacæ* .. .. .. | — .. .. .. .. | — |
| *B. Nos.* 100 *and* 101 .. | 0·5 p.c. .. .. .. .. | 10 p.c. |
| *B. rhinosclerotoma* .. | 0·5 p.c. .. .. .. .. | 1 p.c. |

## Metallography, etc.

**Phosphorus in Cast-Iron.***—F. Wüst and R. Stotz have examined seven series of cast-irons, the phosphorus content in each series ranging from small amounts to 2 p.c., and the percentage of other elements remaining constant. The seven series differed from each other in percentage of carbon, silicon, or manganese. The amount and form of the graphite, which are most readily observed in polished unetched sections, are of primary importance in their effect on mechanical properties; large graphite flakes reduce the strength of cast-iron. A regular constituent of grey cast-iron containing more than 0·1 p.c. phosphorus is the ternary eutectic with a phosphorus content of about 6 p.c. Pearlite containing phosphorus frequently shows dark sorbitic fields, which may be rich in phosphorus. Ferrite or cementite may be present, according to the content of combined carbon. Phosphorus in small amounts has no effect on the graphite, but when it increases beyond 0·6 p.c. the graphite masses collect into groups.

**Hypereutectic Iron-carbon Alloys.**†—O. Ruff further discusses the structure of alloys saturated with carbon at high temperatures and quenched.

**Carbides of Molybdenum.**‡—J. O. Arnold and A. A. Read have examined five steels containing about 0·8 p.c. carbon, with a molybdenum content ranging from 2·4 to 20·7 p.c. At about 18·25 p.c. molybdenum, free carbide of iron disappeared, and a compound $Fe_3Mo_3C$ was obtained. Structures in which this double carbide occurred are described.

**Heterogeneity of Steels.**§—H. Le Chatelier and J. Lemoine recommend the following modification of the Stead reagent for indicating phosphorus segregation in steel:—Methyl alcohol, 100 c.cm.; water, 18 c.cm.; conc. hydrochloric acid, 2 c.cm.; cupric chloride, crystallized, 1 grm.: magnesium chloride, crystallized, 4 grm. The difference, in rate of deposition of copper, between the high and the low phosphorus areas may be intensified by electrolytic action, the specimen being wholly immersed in the reagent, and connected to the positive pole of an accumulator: a copper wire dipping into the reagent is connected to the negative. Greater contrast is thus obtained between the areas which differ in phosphorus content. The proportion of water in the reagent is important. If this is too small, no copper is deposited; if too large, a rapid and uniform deposit of copper is formed. Photomicrographs of transverse sections of a steel plate, etched with different

* Ferrum, xii. (1915) pp. 89–96, 105–19 (19 figs.).
† Zeitschr. Anorg. Chem., lxxxix. (1914) pp. 39–47 (11 figs.).
‡ Journ. Inst. Mech. Eng., 1915, pp. 629–51 (5 figs.).
§ Comptes Rendus, clxi. (1915) pp. 373–8 (9 figs.).

reagents, and demonstrating the superiority of the reagent recommended, are given. The persistence of phosphorus segregation throughout heat-treatment is also illustrated.

**"Ghost-lines" in Steel Forgings.***—A few minutes after the completion of the casting of an octagonal ingot of nickel-chromium steel, weighing about 57 tons, a burst-out occurred at the bottom, and about 17 tons of steel escaped. A hollow shell was thus produced in the upper part of the ingot, and in each internal angle of this shell a series of protruding ribs was found. J. O. Arnold has examined these projections, which he regards as "ghosts." They were found to contain considerably more carbon, sulphur, phosphorus and nickel than the surrounding steel, and to have micro-structures corresponding with their composition. The author considers that the occurrence of these segregated projections indicates that the ghosts in steel are the portions which solidify first, not last, as commonly believed.

**Surface-markings caused by Quenching.**†—B. Bogitch describes a phenomenon apparently due to surface deformations. Small plates of annealed mild steel were polished, heated to temperatures between 200° and 400° C., and quenched in water. Surface-markings, the appearance of which depended on the temperature from which the specimens were quenched, were produced The height of the "folds" was extremely minute.

**The Constituent Alite of Portland Cement Clinker.**‡—E. Jänecke shows by thermal and microscopic evidence that alite, the chief constituent of Portland cement clinker, is a definite compound of the formula $8CaO, Al_2O_3, 2SiO_2$. Photomicrographs in colour, taken with polarized light from thin sections, are given to establish that the compound obtained by melting the powdered oxides together in the electrical arc is identical with alite.

* Journ. Inst. Mech. Eng., 1915, pp. 653–72 (7 figs.).
† Comptes Rendus, clx. (1915) pp. 768–71 (1 fig.).
‡ Zeitschr. Anorg. Chem., lxxxix. (1914) pp. 355–69 (10 figs.)

# PROCEEDINGS OF THE SOCIETY.

## MEETING

HELD ON THE 15TH DECEMBER, 1915, AT 20 HANOVER SQUARE, W., MR. D. J. SCOURFIELD, F.Z.S., ETC., VICE-PRESIDENT, IN THE CHAIR.

**The Minutes** of the Meeting of November 17, 1915, were read and confirmed, and signed by the Chairman.

---

The following Donation received since the last Meeting was announced, and the best thanks of the Society accorded the donor:—

| | From |
|---|---|
| Twelve Slides of Mycetozoa .. .. .. .. | *Mr. Charles Huish, F.R.M.S.* |

**The Chairman** called upon Mr. J. E. Barnard, who described the collection of coloured drawings which were on exhibition in the room, and said they came into his possession some years ago, but he was not certain that he was the owner in the strict sense of the term. He did not know until he came into the room that they were executed by a Mr. Draper, and probably about thirty years ago. There was some description on the back of nearly all of them, but he doubted if it was invariably accurate. The objects with which he was familiar had been reproduced with remarkable fidelity, but he would appreciate any addition to the information on the back of the sketches which Fellows could supply. If the drawings finally came into his possession, he thought they would most fittingly adorn the walls of the Society.

The Chairman expressed the thanks of the Society to Mr. Barnard for bringing the drawings before it. Some reminded him of drawings which were published in "Science Gossip" years ago.

Mr. Earland believed that many of them were the originals of those drawings which came out in "Science Gossip," sometime about 1885 to 1890. There was no question about some; others were new to him. They were beautiful specimens of draughtsmanship.

Mr. Barnard asked if any considerable proportion of them had been published, to which a Fellow replied that "Science Gossip" only published them for two years, one in each number, and that would make only twenty-four altogether.

The vote of thanks was carried with acclamation.

**Mr. Charles F. Rousselet's** communication, "Fifth List of New Rotifers since 1895," was read in abstract by Dr. Eyre, as the author was suffering from laryngitis.

The Chairman thanked Mr. Rousselet on behalf of the Society for this further addition to the list of the Rotifera, and trusted that some day he might be induced to bring out a monograph on the subject.

The vote of thanks was carried with acclamation.

**The Secretary** then read a short communication from Dr. Marshall Ewell, F.R.M.S., on "A New Micrometer" (with sketch).

The Chairman stated that the note would duly appear in the Journal, and he had no doubt it would be found a useful communication. He thought the Society would wish to thank Dr. Marshall Ewell for having sent it.

A vote of thanks was then carried with acclamation.

**The Chairman** then requested Mr. J. E. Barnard, F.R.M.S., to demonstrate the apparatus for "The Employment of Ultra-violet Light in Microscopy." Whilst doing so, Mr. Barnard illustrated some of the results obtained by this method by means of lantern-slides.

The Chairman remarked that Mr. Barnard's work was just the type most welcomed in the Society, and felt sure Mr. Barnard would agree that when the method had been longer in use in the hands of experts like himself, it would probably yield very much more important results than those shown during the evening.

Mr. Maurice Blood said he would like to ask Mr. Barnard one question. He presumed these lenses were corrected for one particular wave-length of ultra-violet light, and they could not be used for accurate work with any other. As a matter of curiosity, he would like to ask him what was the wave-length of the mercury line which he used for focussing?

Dr. Eyre congratulated Mr. Barnard on the results already obtained. Bacteria when examined by ordinary methods appeared to have no internal structure, although it had always been believed that in time the presence of nuclei would be demonstrated. Mr. Barnard's photographs showed indications of structure inside the cell-envelopes which might well be nuclear. The question arose, however, whether the cell-membrane had undergone some distortion in Mr. Barnard's preparations as a result of plasmolysis or similar phenomena. The Society was very much indebted to Mr. Barnard, because his was the kind of communication wanted, real live work pointing out the directions in which advances were needed.

The cordial thanks of the meeting were accorded to Mr. Barnard for his paper.

Mr. Barnard, in reply to Mr. Blood, said the objectives were corrected for the cadmium line primarily. The computation was made on that wave-length. They worked equally well, and in some respects were easier to use, with magnesium electrodes. The cadmium line was 275 $\mu$, a difference of only 8 $\mu$ in the wave-length. There was considerably

greater energy in the magnesium line, so that it was easier to focus the image with the fluorescent eye-piece. There was, however, no difference whatever in the photographic results. He was not sure what was the exact wave-length of the violet line referred to in the spectrum of mercury, probably about $395\,\mu$. It was on the limit of visibility, but was fairly easy to focus with. Dr. Eyre had suggested that the method of mounting the bacteria might possibly cause some change in their appearance. He did not think so, because the organisms were in the living condition, and mounted in $\frac{1}{2}$ p.c. agar, to which had been added physiological salt solution of the same density as the medium in which they were grown. The exposures did not as a rule exceed twenty seconds: ultra-violet light was exceedingly actinic. It was not actively destructive to bacteria: the most destructive area was not of that particular wave-length.

---

**Dr. Eyre** (Secretary) then invited nominations for the Council and Officers for the ensuing year. He explained that Dr. Shillington Scales, who had acted as co-secretary, had recently become very busy in connexion with war work, and the Council had been obliged to comply with his request, and to relieve him of his duties.

The Chairman said the meeting could scarcely be allowed to end without thanking Mr. Shillington Scales for what he had done for the Society in the past, and recording his work on the Minutes. It was a matter of great regret to the Council that he could not continue his work.

The vote was carried with acclamation.

---

**The Chairman** called upon the Meeting to appoint an Auditor on behalf of the Fellows.

It was proposed, seconded, and carried unanimously, that Mr. Joseph Wilson be appointed Auditor to act on behalf of the Fellows.

---

It was announced that the next Ordinary Meeting of the Society would be held on Wednesday, January 19, when Officers and Council for the ensuing year would be elected.

The Biological Section would next meet on January 5.

It was also announced that the rooms of the Society would be closed from Thursday evening, December 23, to Tuesday morning, December 28.

**The following Instruments, Apparatus, etc., were exhibited:—**

Mr. Joseph E. Barnard, F.R.M.S.:—Series of coloured drawings, 120 in all, of botanical, entomological, histological, and marine subjects.

**New Fellows**:—Mr. Joseph Lambert was elected an Ordinary Fellow of the Society, and Dr. Robert Braithwaite, F.L.S., etc., who had been an Ordinary Fellow of the Society since 1866, was elected to an Honorary Fellowship.

## MEETING

Held on the 19th of January, 1916, at 20 Hanover Square, W., Mr. D. J. Scourfield, F.Z.S., Vice-President, in the Chair.

**The Minutes** of the Meeting of December 15, 1915, were read, confirmed, and signed by the Chairman.

---

**The Chairman** expressed the regret of the Meeting at the absence of the President on military duty.

---

The Scrutineers for the ballot, chosen by vote, were Mr. W. Watson Baker and Mr. C. H. Bestow.

---

**The Secretary** announced the donations which had been made since the last Meeting, as follows:—

| | From |
|---|---|
| Monograph of the Ixodoidea. Parts 2 and 3 .. .. | *The Publishers.* |
| A Wilson Screw-barrel Microscope .. .. .. .. .. .. | *Dr. H. J. Johnson through Dr. Hebb.* |
| Foraminifera of the Kerimba Archipelago .. .. .. | *Messrs. Heron-Allen and Earland.* |
| Artificial Daylight Disc .. .. .. .. .. .. .. .. .. | *The Goring Glass Co.* |

---

**The Chairman** asked the Meeting to pass a vote of thanks to those who had been so good as to make these donations, among whom he would like specially to mention Messrs. E. Heron-Allen and Arthur Earland.

This was carried unanimously.

---

**The Secretary** read the Report of the Council as follows:—

### REPORT OF THE COUNCIL FOR THE YEAR 1915.

#### FELLOWS.

*Ordinary.*—During the year, 15 new Fellows have been elected (although only 12 have so far completed the necessary formalities), whilst 5 have died, 15 have resigned, and 5 have been removed. Although

the number of new Fellows elected is not so great as during 1914 by 5, the number of resignations also falls short of the number for that year.

*Honorary.*—The Council regrets to report the death of an Honorary Fellow of the Society in Count Solms-Laubach, of Strassburg, who was elected in 1895 and died on November 25, 1915.

Dr. Robert Braithwaite, F.L.S., etc., who has been an Ordinary Fellow of the Society since 1866, and was President of the R.M.S. during the Session 1891–2, has been added to the List of Honorary Fellows.

The List of Fellows now contains the names of 398 Ordinary, 1 Corresponding, 30 Honorary and 81 Ex-officio Fellows, making a total of 510.

## FINANCE.

The Revenue Account shows a balance of income over expenditure of £117 11*s.* 2*d.*; of this amount the sum of £61 is reserved for the purchase of foreign journals not now obtainable owing to the War.

Compared with last year, the income of the Society shows a further decrease, and the amount owing on the Subscription Account is some £90 16*s.* 6*d.*, in addition to £35 on account of Fellows owing more than two years, and not taken into the Revenue Account.

During the year the Council has purchased £200 of $4\frac{1}{2}$ p.c. War Loan and converted the £200 $3\frac{1}{2}$ p.c. purchased in 1914, thus making the Society's holding in the $4\frac{1}{2}$ p.c. Loan up to £400.

The value of the Society's securities has been written down by £67, and, after adding the War Loan purchased, the Investment Account, stands at £2181 14*s.*

The Capital Account has been left at the same figure as in the last Balance Sheet, and the depreciation in investments has been charged to the Reserve Account which, with the balance from the Revenue Account, now stands at £349 17*s.* 5*d.*

The Council would urge upon the Fellows the imperative necessity for liquid assets in order that the Officers charged with the management of the Society may have adequate funds at their disposal for the maintenance of the Society in the position it should occupy in the world of Science. To this end the annual dues should be paid promptly—that is to say, as early in the financial year, which began on January 1, 1916, as is possible.

## JOURNAL.

The original communications, nine in number, which have appeared in the Transactions, have been of exceptional interest and value, notably those by Dr. Malcolm Burr and Messrs. Heron-Allen and Earland.

The portion of the Journal devoted to abstracts has been carried on on the old lines, and continues to be found most useful to workers.

The best thanks of the Council are due to the Editorial Staff for the continuance of their labours and their excellent contributions.

### LIBRARY.

The Library is in good order, and the number of books and periodicals borrowed by Fellows during 1915 compares very favourably with that of the previous year.

Owing to the generosity of authors and publishers many useful and important works have been added to the Collection.

### INSTRUMENTS AND APPARATUS.

The instruments and apparatus in the Society's Collection continue to be in good condition.

During the past year only one donation has been received, as follows:

March 17.—An old simple Microscope (supposed to have been made by Cary), presented by Mr. Sydney C. Akehurst, F.R.M.S., which has been incorporated into the Society's Collection.

### GAUGES.

The Council has this year issued the revised specifications for the R.M.S. Standard Objective Screw and Eyepieces, and has deposited the R.M.S. Standard Gauges with the Director of the National Physical Laboratory, where they will be available for public reference.

New standard Sizing Taps and Dies have been obtained and tested by the National Physical Laboratory, and are now on sale.

The Council is gratified to announce that as the outcome of the deliberations of the Microscope Committee of the British Science Guild (which included representatives of the R.M.S.), the R.M.S. Standards have been incorporated in the specifications of certain standard Microscopes; and the British makers have been recommended to concentrate their energies upon these Standard types at the termination of the War, in order to prevent Germany recovering its hold on the English trade.

### CABINET.

During the year twelve slides of Mycetozoa, which were kindly presented to the Society by Mr. Charles H. Huish, F.R.M.S., have been added to the Society's Cabinet.

A Sub-Committee consisting of four Fellows (Messrs. D. J. Scourfield, C. F. Rousselet, John Hopkinson, and E. J. Sheppard) has been formed for the purpose of reporting upon the best means of classifying the Society's collection of slides. One meeting has been held, but the Committee is not yet prepared to formulate recommendations.

### MEETINGS.

During the year 1915 nine Ordinary Meetings have been held, which, in the earlier months of the year, were well attended, but latterly,

owing to the abnormal conditions occasioned by the War, there has been some falling off in the numbers attending the meetings.

The demonstrations which have been carried out have also been of an importance which evoked corresponding enthusiasm, particularly those by Mr. Barnard in connexion with the application of X-rays and of Ultra-violet light to Photomicrography.

The Biological Section, under the Secretaryship of Mr. Scourfield, has maintained its reputation for interesting communications, and the excellent attendance at the meetings. This section has held eight meetings, with an average attendance of twenty. A number of well-attended excursions has also been made during the session to various laboratories and scientific institutions, and have proved highly interesting and successful.

**Mr. Cyril F. Hill** (Treasurer) read the Financial Statement for the year 1915, and, after commenting on various points, remarked that with reference to the subscriptions, Fellows would have noticed the paragraph in the Report urging the payment of arrears of subscription. During the last year there had been considerable trouble in getting in the subscriptions; he supposed it was on account of the War, as some Fellows seemed to be under the idea that the Moratorium applied to the Society's subscriptions long after the true Moratorium had ceased. He did not know how the Society would fare if that impression became at all general. The balance seemed satisfactory, as far as it went, seeing that the Journal kept up its reputation.

Mr. Hiscott proposed, and Mr. Watson Baker seconded, the adoption of the Report of the Council and that of the Treasurer, and this was carried.

**The Chairman** announced that the result of the scrutiny of the Ballot was the election of the whole of the Council's nominees as follows:—

*President.*—Edward Heron-Allen, F.L.S., F.Z.S., etc.

*Vice-Presidents.*—John Hopkinson, F.L.S., F.Z.S., F.G.S.; J. E. Barnard; Arthur Earland; F. Shillington Scales, M.A., M.D.

*Treasurer.*—Cyril F. Hill.

*Secretaries.*—John W. H. Eyre, M.D., F.R.S. Edin.; David J. Scourfield, F.Z.S.

*Ordinary Members of Council.*—H. F. Angus; C. Lees Curties; A. N. Disney, M.A., B.Sc.; R. G. Hebb, M.A., M.D., F.R.C.P.; R. T. Hewlett, M.D., F.R.C.P.; J. Milton Offord; R. Paulson; Percy E. Radley; C. F. Rousselet; E. J. Sheppard; C. D. Soar; J. Wilson.

*Librarian.*—Percy E. Radley.

*Curator of Instruments, etc.*—Chas. F. Rousselet.

*Curator of Slides.*—Edward J. Sheppard.

*Editor of Journal.*—R. G. Hebb, M.A., M.D., F.R.C.P.

## REVENUE ACCOUNT FOR THE YEAR ENDING 31ST DECEMBER, 1915.

**Dr.**

| | £ s. d. | £ s. d. |
|---|---|---|
| To Journal .. .. .. .. .. .. .. .. .. .. | | 528 17 6 |
| ,, Rent and Insurance .. .. .. .. .. .. .. .. | | 165 4 0 |
| ,, Salaries and Reporting .. .. .. .. .. .. .. | | 121 18 9 |
| ,, Sundry Expenses, including Postages .. .. .. .. | | 26 8 10 |
| ,, Library, Books, Papers and Stationery .. .. .. .. | | 28 8 7 |
| ,, ,, Reserved for purchase of Foreign Journals not obtainable during War .. | £61 0 0 | |
| ,, Balance .. .. .. .. .. .. .. .. .. | 116 11 2 | |
| | | 177 11 2 |
| | | £1048 8 10 |

**Cr.**

| | £ s. d. | £ s. d. |
|---|---|---|
| By Subscriptions .. .. .. .. .. .. .. .. | 672 18 7 | |
| ,, *Less* Subscriptions of Fellows more than two years in arrear .. .. .. .. .. | 35 0 0 | |
| | | 637 18 7 |
| ,, Admission Fees .. .. .. .. .. .. .. .. .. | | 25 4 0 |
| ,, Sales of Journal .. .. .. .. .. .. .. .. .. | | 264 12 9 |
| ,, ,, of Sundries .. .. .. .. .. .. .. .. | | 3 7 9 |
| ,, Interest on Investments .. .. .. .. .. .. .. | | 85 9 0 |
| ,, Advertisements .. .. .. .. .. .. .. .. .. | | 31 16 9 |
| | | £1048 8 10 |

## BALANCE SHEET, 1915.

**Dr.**

| LIABILITIES. | £ s. d. | £ s. d. |
|---|---|---|
| To Capital Funds Account .. .. .. .. .. .. .. | | 2127 17 4 |
| ,, Show Case Fund .. .. .. .. .. .. .. .. | | 12 15 9 |
| ,, Sundry Creditors .. .. .. .. .. .. .. .. | | 151 7 1 |
| ,, Reserve Account as at Dec. 31, 1914 .. | £239 6 3 | |
| *Less* Depreciation on Investments .. | 67 0 0 | |
| | 172 6 3 | |
| *Add* Balance from Revenue Account .. | 116 11 2 | |
| Reserve for Library .. .. .. | 61 0 0 | |
| | | 349 17 5 |
| | | £2641 17 7 |

**Cr.**

| ASSETS. | £ s. d. | £ s. d. |
|---|---|---|
| By Cash at the Bank .. .. .. .. .. .. | 73 2 7 | |
| ,, ,, on Deposit .. .. .. .. .. .. .. | 50 0 0 | |
| ,, ,, in Hand .. .. .. .. .. .. .. | Nil | |
| | | 123 2 7 |
| ,, Investments as per last Balance Sheet— | | |
| £400 North British Railway 3 %, Deb. | | |
| £500 Nottingham Corporation 3 % .. | | |
| £400 New South Wales 3½ % .. .. | | |
| £915 India 3 % .. .. .. .. .. .. | | |
| £150 Metropolitan Water Board 3 % | | |
| £200 War Loan 3½ % .. .. .. .. .. | 2039 15 4 | |
| *Less* Depreciation .. .. .. .. | 67 0 0 | |
| At Market Valuation, Dec. 31, 1915 | 1972 15 4 | |
| Purchased during 1915— | | |
| £200 War Loan 4½ % .. .. .. .. .. | 208 18 8 | |
| | | 2181 14 0 |
| ,, Sundry Properties, Office and Library Furniture .. .. .. .. .. .. .. .. .. .. .. | | 88 2 0 |
| ,, Purchase of Screw Gauges .. .. .. .. .. | 28 6 0 | |
| *Less* Sales .. .. .. .. .. .. .. | 3 3 0 | |
| | | 25 3 0 |
| ,, Sundry Debtors .. .. .. .. .. .. .. .. .. .. .. | | 223 16 0 |
| | | £2641 17 7 |

We have examined the foregoing Account, and compared the same with the Vouchers in the possession of the Society. We have verified the Securities as above mentioned, and find the same correct.

CHAS. D. SOAR, } *Auditors.*
J. WILSON, }

CYRIL F. HILL, *Treasurer.*

The Chairman then invited the new President, Mr. Edward Heron-Allen, to take the Chair.

**Mr. Heron-Allen** then occupied the Presidential chair, and said: —

Mr. Vice-President, Ladies and Gentlemen,—Mingled with a keen sense of the honour which has been conferred upon me by calling me to occupy a Chair which has added additional lustre to a long list of names already in themselves illustrious, I should feel an almost paralysing sense of diffidence were it not that I fully realize that I have been called to fill this position under circumstances different to those under which the majority of my predecessors have accepted the office which by your election I now hold. I feel that I have been elected in the evening of a long day of useful work. As a Society we stand at a critical point, and I feel that this year, pregnant as it is with great issues, owing to the prevailing conditions of life, will decide whether that evening is to end in permanent night or to be the precursor of a dawn of new activities, a dawn that shall usher in a day not less bright than its predecessor, a day of renewed scientific effort and of useful results I think that the Council as delegates of the Society have realized that at the present juncture something other is wanted than the ægis of a Great Name, and that (borrowing example from the world of commerce), as in the case of old-established family businesses which are suffering from self-complacent conservatism, they have sought to place the Society for a time in the hands of a new Managing Director, who has perhaps had exceptional opportunities of noting the needs of the Society.

We must not lose sight of the fact that when this Society was founded in the year 1840, the Microscope as we know it was so essentially in its infancy that we may almost say that it had not been invented. As Professor Herdman says in his recent "Life of Edward Forbes," whom he rightly calls the Father of Oceanography, "it is curious to recall nowadays that the study of histology and microscopic structure in general was only introduced into medical study in 1841, by Professor Hughes Bennett, who had been a fellow-student of Forbes." From that time for many years the mere possession of a Microscope may almost be said to have formed a branch of science. To say that those times have changed is to enunciate the baldest of truisms. The Microscope is now an indispensable adjunct, not only to every branch of science, but to most trades. But though its applications have thus been widely dispersed, its essential and peculiar scientific principles remain as a field of specialized scientific enquiry, and this becomes more apparent every day in these times of profounder and ever-widening research. The duty of this Society is to record the progress of microscopic research, and that it has done so in a manner especially its own is shown in the pages of our Journal. It is our first duty to encourage the development of microscopic technique and appliances, and it is for this reason that our Journal maintains its high reputation under the able management of the Editors, and may be said to keep our Fellowship together. This is a side of our work to the furtherance and development of which I am determined to spare no effort or time whilst I occupy this Chair.

It is with this object in view that next month Mr. Rousselet, Mr. Earland and myself propose to give an Exhibition, and a joint paper "On the Progress and Development of Vision and Definition under the Microscope," which will be practically illustrated by an exhibition of the same microscopic object (an object which provided the earliest microscopists with subjects of illustration), exhibited both by reflected and transmitted light under a long series of Microscopes from the Society's collection, which will be specially renovated and mounted for the purpose by Mr. Lees Curties.

In this connexion I regard it as essential that the Illustrated Catalogue and Description of the Society's Collection of Microscopes should be completed without delay, and such practical assistance as I can give for the accomplishment of this end will be given regardless of any considerations of time, trouble, or expense.

I propose that at the same meeting a Symposium shall be held of as many Fellows as can make it their duty to attend, in order that the Council may have before them the views of the Fellows upon the steps to be taken to enlarge the operations of the Society.

The fact is abundantly manifest to those Fellows that have served upon the Council of the Society that the members at large do not know what is happening in the Society or what is going to happen, and therefore they do not order their arrangements so as to be able to attend the meetings. I have made it my business to analyze the attendance at meetings for the past two years, and the results are far from uninteresting or uninstructive. The average attendance of Fellows of the Society, not being members of the Council, in 1914 was 23; in 1915 it was 17. The average attendance of visitors in 1914 was 20, and in 1915 15·3. (In this figure must be taken the attendance of visitors and their friends on the Pond Life evening, which amounted to 85—more than one-third of the total.) The average attendance of Officers and the Council, who number 21, was in 1914 12·2, and in 1915 11·2. This is a condition of things which must be altered, and in my opinion the only way in which an alteration can be brought about is by the construction of a Programme which will attract, not only our own Fellows, but members of other leading scientific societies. Among the latter there exists a wide impression that the Society, as a society, is *functus officio*—that its reason for existence has waned, if it has not vanished—and this is an impression which only our own efforts can relieve.

I have therefore devoted some time and what little influence I possess in the scientific world, since receiving the invitation of the Council to occupy the position which I now hold, to lay the foundations of such a Programme. I have told you what is proposed for the February Meeting, and I consider that that will be one of the most important meetings that the Society has held for many years. In March, our late President, Professor J. Arthur Thomson, will deliver an address on "Original Factors in Evolution." In April, Professor Benjamin Moore, F.R.S., will deliver an address on "Early Steps in the Evolution of Life." In May, the Pond Life meeting will take place as usual, but it will be more than a mere exhibition of microscopic objects

inadequately explained to unaccustomed ears, in a stage whisper, by harassed exhibitors. The Fellows and Visitors who assist the Council on that occasion will be invited to send a note of their exhibits beforehand to Mr. D. J. Scourfield, who will deliver an address dealing shortly with each exhibit, which address will be supplemented, as he proceeds, by the exhibitors themselves.

In June, I hope that Mr. J. E. Barnard will communicate to the scientific world, through the medium of this Society, the progress and results of some of his studies in branches of microscopic research which, it is common knowledge, are awaited with impatient interest by a very large circle of scientific men.

When we reassemble after the summer recess we shall have, unless conditions have by that time rendered it impossible, a paper by Professor S. J. Hickson, F.R.S., Professor of Zoology in the University of Manchester, on the branch of zoology with which his name is especially connected, and one by Mrs. Helen Pixell Goodrich upon the history of and the recent work that has been done upon the mysterious dental disease known as Pyorrhœa. I am in communication with other specialists no less eminent with a view to other and not less important communications.

Now, all these subjects, of which a Programme will be issued as soon as possible, are subjects upon which certain of our Fellows have made special studies, and in the name of the Council I invite such Fellows to come forward with the offer of papers on kindred subjects which may be grouped on the same evenings; and, to go back to the principle which I enunciated at the beginning of my address, at all the meetings a special feature will be made of the technical methods to be employed with a view to showing the obtained results in the highest perfection which the progress of scientific Microscope construction has rendered possible.

In conclusion, I may say that I hope before the next meeting to communicate the substance of what I have now said to all Fellows of the Society who should be able to attend our meetings, and to take part in what I hope will be, and which no effort of mine will be spared to make, a new era in the History of the Royal Microscopical Society.

---

**Mr. Scourfield** then read Mr. Rousselet's notes explanatory of the exhibition of "Statoblasts of Fresh-water Protozoa," arranged under the Microscopes upon the tables.

**The President** said the Society was favoured with the presence of Dr. Harmer, F.R.S., of the Natural History Museum, and he would be glad if that gentleman would favour the Society with some commentaries on the remarkable collection of Statoblasts exhibited by Mr. Charles F. Rousselet.

Dr. S. F. Harmer thanked the President for kindly inviting him to be present, and for speaking such appreciative words to the Society. He feared, however, that he could not claim to possess any special

knowledge of statoblasts, though he had studied Polyzoa generally. He had not, up to the present, had the opportunity of seeing the slides which Mr. Rousselet had prepared for inspection. Still, he felt sure they would be mounted in a way which would be as perfect as possible, as Mr. Rousselet was a master in regard to mounting small delicate objects. He had had the opportunity himself of learning many useful hints from Mr. Rousselet with regard to some of the Polyzoa, which are remarkable in being extraordinarily difficult to mount, especially in Canada balsam.

Dr. Harmer then spoke at some length on the function of statoblasts, and the discussion was continued by Messrs. Earland, Scourfield, and the President. Mr. Rousselet's notes and the subsequent discussion will be published *in extenso* in the body of the Journal.

The President said he was sure Fellows would wish to express their hearty thanks to Mr. Rousselet for his fascinating exhibition, and to Dr. Harmer for his illuminating remarks.

This was carried by acclamation.

---

A paper on "Alien Oligochætes in England," by the Rev. Hilderic Friend, was then taken as read, and ordered to be published in the Society's Journal.

---

**The President** proposed a vote of thanks to the Honorary Officers and to the Scrutineers. Both were carried unanimously.

In proposing a cordial vote of thanks to Messrs. Baker for the loan of the Microscopes, the President said it was more than a formal expression. For Mr. Curties to bring down such a quantity of Microscopes was no small matter in normal times, but when so much apparatus was commandeered by the Government, and the firm was working with but quarter-staff, it was a matter for gratitude that Mr. Curties should have assisted the Society in the manner he did, and called for a special vote of thanks.

This was carried by acclamation.

---

**The President** announced that the next Meeting would be held on February 16, and that the next meeting of the Biological Section would take place on Wednesday, February 2, when Mr. Soar would make a communication on "Some Rare Water-mites."

---

**New Fellow.**—Lieut. Wm. R. Patterson was elected an *Ordinary* Fellow of the Society.

JOURNAL
OF THE
# ROYAL MICROSCOPICAL SOCIETY.

APRIL, 1916.

## TRANSACTIONS OF THE SOCIETY.

### IV.—*The Supposed Exhibition of Purpose and Intelligence by the Foraminifera.*

By Sir Ray Lankester, K.C.B., F.R.S.

(*Read March* 15, 1916.)

A great teacher, observer and thinker, Dr. William B. Carpenter—who was President of this Society, and did more to increase our knowledge of the Foraminifera than any other naturalist either before or since his day—first drew attention to the elaborate and skilful construction of their tests, to which Mr. Heron-Allen has recently added many beautiful and striking instances. It is only just to Dr. Carpenter's memory that we who have built upon his pioneer work, in so many directions, should recall his observations and reflections on this subject. In his valuable treatise entitled "Mental Physiology" (1874, p. 41), Dr. Carpenter, after describing the activities of Amœba in *selecting* and engulfing food particles by means of its pseudopodia, writes as follows concerning the Foraminifera: "We can scarcely conceive that a creature of such simplicity should possess any distinct *consciousness* of its needs, or that its actions should be directed by any *intention* of its own; and yet the writer has lately found results of the most singular elaborateness to be wrought out by the instrumentality of these minute 'jelly-specks,' which build up 'tests' or casings of the most regular geometrical symmetry of form, and of most artificial construction. Suppose a human mason to be put down by the side of a pile of stones of various shapes and sizes, and to be told to build a dome of these, smooth on both surfaces, without using more than the least possible quantity of

a very tenacious but very costly cement in holding the stones together. If he accomplished this well, he would receive credit for great intelligence and skill. Yet this is exactly what these little 'jelly-specks' do on a most minute scale, the tests they construct, when highly magnified, bearing comparison with the most skilful masonry of man. From *the same sandy bottom* one species picks up the coarser quartz grains, cements them together with *phosphate of iron* secreted from its own substance, and thus constructs a flask-shaped 'test' having a short neck and a single large orifice. Another picks up the *finest* grains and puts them together with the same cement into perfectly spherical 'tests' of the most extraordinary finish, perforated with numerous small pores, disposed at perfectly regular intervals. Another selects the *minutest* sand-grains and the terminal portions of sponge-spicules, and works these up together—apparently with no cement at all, by the mere 'laying' of the spicules—into perfect white spheres, like homœopathic granules, each having a single fissured orifice. And another, which makes a straight, many-chambered 'test,' that resembles in form the chambered shell of an orthoceratite—the conical mouth of each chamber projecting into the cavity of the next—while forming the walls of its chambers of ordinary sand-grains rather loosely held together, shapes the conical mouths of the successive chambers by firmly cementing together grains of ferruginous quartz, which it must have picked out from the general mass.

"To give these actions the vague designation 'instinctive' does not in the least help us to account for them, since what we want is to discover the *mechanism* by which they are worked out; and it is most difficult to conceive how so artificial a selection can be made by a creature so simple." (Here follows a description of the tube-building of the marine worm *Terebella*, a far more highly differentiated organism, which again suggests comparison with the wonderful skill of the caddis-worms in the selection and mechanical adaptation of the fragments of plant-stalks, shells, and chopped weed used by various species in the construction of their tubes or cases.) "We can only surmise," Dr. Carpenter continues, "that in the humble Rhizopods, as the whole of each 'jelly-speck' possesses the attribute of contractility elsewhere limited to muscles, so may the attributes which are restricted in the higher types of animal life to the nervous apparatus be there diffused through every particle—the whole protoplasmic substance being endowed in a low degree with that power of receiving, conducting and acting upon external impressions which is raised to a much more exalted degree when limited or specialized in the nervous system."

Every word of Dr. Carpenter's reflections (of forty years ago) on the architectural and selective skill of the Foraminifera appears

to me to apply to the examples recently brought to our notice by Mr. Heron-Allen, as well as to those known in 1874; and for my own part I could not, and should not, wish to modify them. Mr. Heron-Allen has, however, been tempted, as the result of a consideration of the facts observed, to ascribe what he at first called "Purpose and Intelligence," and now calls "faculties *akin* to Purpose and Intelligence," or (by further modification of his terms) "Purposive Intelligence," to the Foraminifera. In the present communication I avail myself of Mr. Heron-Allen's statement of his views and opinions read to the Society on October 20, 1915, and published in our Journal for December (p. 547). I agree with Mr. Haynes in the opinion, quoted by Mr. Heron-Allen, that "our human vocabulary is at present most inadequate for discussing problems of this kind." And I am not assisted by Mr. Heron-Allen's latest statement in coming to a conclusion as to what he thinks he has discovered, or how he supposes that his terms are more than a re-statement in dubious phraseology of the facts familiar to all biologists since the days of Carpenter and Huxley. He says that he repudiates the inference that the "Purposive Intelligence" displayed by a Protozoon "is in any way comparable to that displayed by a man or by animals, vertebrate or invertebrate." Finally, he declares that his conclusion is that there is no organism in the animal kingdom, however simple be its structure, "which is not capable of developing functions and behaviour which in the Metazoa might be called (and would properly be so called) 'Phenomena of Purpose and Intelligence.'" That is precisely the point from which we started in 1874, as stated in the citation from Dr. Carpenter given above. Mr. Heron-Allen has already told us that what he alludes to as "Purposive Intelligence" in the Protozoa is not, in his opinion, in any way comparable to that displayed by man or by any animal, vertebrate or invertebrate. How, then, do we get further by the aid of Mr. Heron-Allen's "postulates" than the position already reached by Dr. Carpenter, and the long line of his and Huxley's followers? It is difficult to admit that the words "Purpose" and "Intelligence," which are primarily applied to certain mental activities exhibited by man, can be applied with any advantage to phenomena which are at the same time explicitly declared to be not comparable with those human phenomena.

It appears to me that Mr. Heron-Allen gains nothing by describing the architectural and selective proceedings of the Protozoa in other terms than those which have long been current —namely, that they are surprising exhibitions of constructive and selective activity. To say that they are due to Purpose which is *not* Purpose as the word is ordinarily understood, and to Intelligence which is *not* Intelligence in the usual acceptation of the term, seems to me to tend to misconception, and to a mistaken

notion that we know more about the activities of the Protozoa than we do.

It appears to me not difficult to conceive of the existence of a mechanism in the protoplasm of the Protozoa which selects and rejects building material, and determines the shapes of the structures built, comparable to that mechanism which is assumed to exist in the nervous system of insects and other animals which "automatically" go through wonderfully elaborate series of complicated actions. Darwin and others have attributed the building up of these inherited mechanisms to the age-long action of Natural Selection, and the survival of those individuals possessing qualities or "tricks" of life-saving value. I therefore disagree with Mr. Heron-Allen's opinion that the architectural and selective phenomena exhibited by the Foraminifera "have," if I may quote his words, "no relation to Adaptations and Tropisms." On the contrary, they not only have, in my judgment, a close relation to such phenomena, but are of the same nature.

In reference to the continuity of the psychical activities of man with those of lower animals, Huxley's conclusion on this matter long ago commended itself to me (as to most biologists) when he says (as cited by Mr. Heron-Allen), "No structural line of demarcation can be drawn between the animal world and ourselves; and I may add the expression of my belief that the attempt to draw a psychical distinction is equally futile, and that even the highest faculties of feeling and of intellect begin to germinate in lower forms of life." My own belief in a continuous and gradual development of the highest animals, including man, from such simple beginnings as are to-day represented to us by the Protozoa, does not lead me to assume the existence of the vertebrate notochord, nor even of something akin to that structure, either in Protozoa or in the fertilized egg-cell, from which a man is slowly and regularly developed. Nor does that belief lead me (as Mr. Heron-Allen seems to think it should) to assume the existence in them of mental activities of a high order such as Purpose, defined in the Oxford Dictionary as "the action or fact of intending or meaning to do something; intention, resolution, determination," and of which an eminent scholar says:—"No such thing as blind or unconscious purpose is conceivable." That belief does not necessitate the assumption that Intelligence and Consciousness exist in Protozoa on the one hand, or in the human fœtus on the other. Nevertheless, I know that the dull, unconscious, purposeless fœtus becomes by gradual evolution the new-born babe, the child, the man, and that it was itself gradually evolved from the fertilized egg-cell. There is no break in the series, although there is no manifestation of Purposive Intelligence in the fœtus, or of a notochord in the many-celled germ. Both skeletal structure and high mental qualities are gradually acquired "without a break" in the growth of man from the egg.

And as the marvellous evolution can, and does, take place every day in the due order of reproduction, I see no difficulty in supposing that a similar evolution has taken place in the passage from Protozoa to Man, and no reason for holding that high psychical activities are present in Protozoa on the ground that if they were not there present their subsequent evolution in the course of geologic time would involve a break in the developmental series—a sudden discontinuity.

If we once recognize the fact that mental faculties are, like human structure, immensely complex, and are dependent for their manifestation on the healthy activity of an almost inconceivably complex structure—the brain—we shall, it seems to me, be able to conceive of the reduced or less complex mental faculties of less elaborate brains. Descending step by step we shall arrive at the conception of the microscopic mentality of a Foraminifer, and cannot fail to dismiss the notion of attributing to it Purpose and Intelligence, or anything which can seriously be called by those names.

The PRESIDENT, in rejoinder to the above note, and in reply upon the discussion which ensued, made the following observations:—

I cannot but regard it as an honour that my friend Sir Ray Lankester should have undertaken the useful, but often ungrateful, office of *advocatus diaboli* upon the questions which I have raised and the principles which I have formulated upon a subject which in my opinion has lain dormant far too long. It seems to me, however, that there is little or nothing between us beyond a few points of terminology and degree, and that the limitations of language and the elastic interpretation of terms are alone responsible for such differences as may exist between our points of view and consequent conclusions. The late John Stuart Mill formulated the axiom that "it is the aim of the physical philosopher to determine what are the fewest and simplest assumptions from which, being granted, the whole existing order of nature would result." * As Sir Ray Lankester points out, I first made use of the phrase "Purpose and Intelligence"; this I modified later to "Purposive Intelligence," and to-day I would rather use the term "Definitive Purpose," or, perhaps finally, "Purposiveness"—without prejudice to any terminological improvement which may later suggest itself to me.

I agree with my critic in his view that Dr. Carpenter did more to increase our knowledge of the Foraminifera than any other naturalist *since* his day, but the greatest and most unassailable, and indeed unassailed, contribution to our knowledge was made

* Mill's "Logic," 3rd ed. i. p. 327.

before his day by Félix Dujardin, to whom is solely due the discovery of what the Foraminifera really are, a discovery beyond which no zoologist has made any essential progress.*

I cannot agree that the long passage quoted from Dr. Carpenter weakens the foundations of a belief in the remarkable pre-eminence of the Foraminifera as exhibiting phenomena of purposiveness; on the contrary, I claim Carpenter as the earliest and most convinced and convincing supporter of the views which I have expressed. The passage quoted by Sir Ray Lankester is one of the countless illustrations contained in that fascinating work of the unconsciously, but essentially "purposive" processes to be observed among the lower animals. The primary object of the author was to lead up from these phenomena exhibited by the lower animals to the reflex actions—e.g. coughing—of the higher animals, and he comments upon them later on (Op. cit. pp. 56, 57) that "instinctive actions are as truly 'reflex' in their character as those we have been considering, but differ from them only in their greater complexity: . . . the truly instinctive actions of the lower animals correspond in character with the *sensori-motor* or *consensual* actions in man, but constitute a far larger proportion of their entire life work." And a few lines below the passage quoted by Sir Ray Lankester, he makes the startling, but in my opinion justifiable, observation, "The apparent absence of a nervous system is doubtless to be attributed in many instances to the general softness of the tissues of the body (of the Rhizopoda) which prevents it from being clearly made out among them" (Op. cit. p. 44). Surely a passage which we may read side by side with the opinion of Claparède and Lachmann: "Le sarcode des Rhizopodes n'a pas encore trouvé son acide chromique."†

I may perhaps allow myself one or two quotations from the same work. He says: "No scientific psychologist has any doubt that there are 'Laws of Thought' expressing sequences of mental activity which (if we could thoroughly acquaint ourselves with them) would be found as fixed and determinate as the 'Laws of Matter'; the difficulty in ascertaining them arising solely from the difficulty in subjecting mental phenomena to precise observation, and in analysing the complex conditions under which they occur, there are a great number of mental phenomena which cannot be accounted for in any other way than as resulting from the operation of a physiological mechanism which may go on not only *automatically* but even *unconsciously*." ‡

The section in the work we are considering devoted to "reflex" and "instinctive" actions, is mainly devoted to proving

* F. Dujardin, "Observations sur les Céphalopodes Microscopiques." Ann. Sci. Nat., ser. 2, iii. (1835) p. 108 (January); p. 312 (June); iv. p. 343 (December); and Comptes Rendus, 1835, p. 338 (November).

† "Étude sur les Infusoires et les Rhizopodes," Mem. Inst. Nat. Genévois, vi. (1858) p. 414.

‡ W. B. Carpenter, "Mental Physiology," London, 1874, p. 15.

the necessity of an external stimulus to set them in motion. That the Foraminifera respond to stimuli is an ascertained fact. In a laboratory observation-tank of my own, measuring three-quarters of an inch from back to front, in which a plant of Enteromorpha is growing, I have made a crowd of Miliolidæ, Gromiidæ, and Polystomellidæ cross from one side to the other a dozen times, "climbing" from one Enteromorpha blade to another by means of their pseudopodia, by merely turning first one side and then the other to the light. By "prodding" the aboral end of Gromia with a needle I have made them discharge the whole of their protoplasmic bodies into the water, and so die. By touching the extended pseudopodia by which Miliolidæ hang from, and move about upon, the surface-water-layer of a tank * I have made them shrink below the surface, hanging in a sort of "funnel" of pseudopodia. I merely record these observations in this place, without comment.

As a final quotation from this work of Dr. Carpenter I take the following passage (§. 94, p. 105): "Whilst, however, we fully recognize the possession by many of the lower animals of an intelligence comparable (up to a certain point) with that of man, we find no evidence that any of them have a volitional power of *directing* their mental operations at all similar to his." I should be sorry if any words of mine should convey an impression that I thought otherwise, but I cannot resist the citation of an example given by Carpenter (Op. cit., p. 87). He tells us of "a domesticated stork, which was accustomed to receive its food every evening about six o'clock with the ordinary poultry; and the latter, being usually allowed to roam at large in the streets, were collected together at the proper time by a man who went through the town in search of them. The stork, after having thus learned not to expect its food until the poultry had been all collected, spontaneously accompanied the collector, and assisted him in bringing the fowls together; and after doing this for a considerable time, becoming gradually more and more independent and self-relying, it became quite competent to perform this duty for itself, and was at last entrusted with it, so that it might be seen on any evening gravely perambulating the town, collecting its flock of poultry, and driving them home just as a shepherd's dog collects the sheep."

It appears to me that the theory which I have endeavoured to develop, without claiming to have originated it, derives support from the following lines, taken from the passage quoted by Sir Ray Lankester :—"The attributes which are restricted in the higher types of animal life to the nervous apparatus may be (*in the Rhizopoda*) diffused through every particle—the whole proto-

* An observation which I thought was new, but which I find was made by Dujardin in 1835. Op. cit. ante.

plasmic substance being endowed in a low degree with that power of receiving, conducting, and acting upon external impressions which is raised to a much more exalted degree when limited or specialized in the nervous system." I have always endeavoured to point out that it is, in my opinion, only to a degree appropriate to their organization, and not in its entirety, that the behaviour of the Rhizopoda is comparable with that of man.

I do *not* wish to convey the notion "that we know more about the activities of the Protozoa than we do," but I do wish to convey that we know more than we *did*, and that in time we shall know a great deal more. My critic admits that "it is not difficult to conceive of the existence of a mechanism in the protoplasm of the Protozoa, comparable to that mechanism which is assumed to exist in the nervous system of insects and other animals," and I do not seek to put the matter higher than that, but I do join issue with him when he refers these phenomena to "the age-long action of Natural Selection and the survival of those individuals possessing qualities or 'tricks' of life-saving value," for, among the Foraminifera, the individuals which I have chosen to illustrate my views are not the general mass of the survivors—they constitute an infinitesimal, and, if I may dare to say so, a progressive minority. That they may owe their capacity of progressiveness (or of "'self-expressing experimentation," as Professor J. Arthur Thomson would say), to the elimination of dull and irresponsive ancestors, I do not for a moment dispute.

I am not arguing for the possession of "high" skeletal structure, or mental activities in the Protozoa—it is obvious that these must be as rudimentary as they are in any egg—but in that rudimentary condition it seems to me that they must be there, awaiting the stimulus that calls them into action. Long before Carpenter wrote, no less an authority than Albert Gaudry spoke of "the ray of intellectual light which the Author of Nature has allotted to the most humble creatures." *

I cannot conclude in words more satisfactory to myself than in Sir Ray Lankester's own, when he says:—"Descending step by step we shall arrive at the conception of the microscopic mentality of a Foraminifer"; and I wholly dismiss the notion of attributing to it "Purpose" and "Intelligence," as these terms are defined in the Oxford Dictionary.

* The passage is worth quoting. He says: "Pour connaître les animaux il ne suffit pas d'étudier leurs caractères extérieurs ou anatomiques, il faut assister à leur vie, surprendre leurs mœurs, découvrir leur instinct, ce rayon de lumière intellectuelle que l'Auteur de la nature a distribué aux créatures les plus humbles."—A. Gaudry, in "Revue des Deux Mondes," xix. (1859) p. 818.

## V.—*Statoblasts of Fresh-water Polyzoa.*

By C. F. Rousselet.

(*Exhibit and Demonstration, January* 19, 1916.)

Statoblasts are the most characteristic structures in the reproduction of fresh-water Polyzoa. Their form is very stable (except in closely allied species), and each group has characters of its own by means of which it can readily be recognized, even when no trace of the adult polyp or the zooecium has been preserved. Statoblasts are confined to the phylactolæmatous Polyzoa; the other fresh-water species, such as *Victorella, Paludicella, Pottsiella, Urnatella* and *Hislopia* do not produce them, nor do they occur in any of the marine species.

The statoblasts are essentially non-sexual resting buds formed in a structure called the "funiculus" to tide over the rigour of the winter. In most cases they consist of a central capsule surrounded by air-cells or swimming-ring, which renders the structure buoyant, and enables the statoblast to float on the surface of the water when liberated by the decay of the zooecium. In this way a wide distribution and preservation of the species is secured at the same time.

On the appearance of warmer weather the young polyp, in an advanced stage of development, splits open the cellular envelope at the edges. This is effected in different ways in different species.

*Cristatella* has a circular statoblast with numerous hooked spines attached to both the surfaces. In emerging the embryo lifts the lid, like a pill-box with a flange attached, and the hooks are then seen to be attached, some to the lid and some to the base of the box.

In *Pectinatella*, which has fewer but larger hooked spines, the opening takes place along the margin of the statoblast, and even the spines are divided and split horizontally.

*Lophopus crystallinus* has a statoblast pointed at both ends, whilst in *Lophopus capensis* the ends are prolonged into elongated hooked structures; in opening the splitting takes place through the length of these structures, leaving the hooks partly adherent to the upper and partly to the lower half.

In *Lophopodella*, also, the splitting takes place through the length of the finger-like processes, with the hooks attached to each half of the processes.

*Fredericella* differs from the other forms in that its statoblasts

are bean-shaped, and devoid of a swimming-ring; these, therefore, do not float, but fall to the bottom of the pond or lake.

*Paludicella* is a gymnolæmate Polyzoon, and has therefore no statoblasts. It produces, however, small winter buds, or "hibernacula," which serve the same purpose. The hibernacula are soft when first formed, and adhere to submerged stones, or rootlets of trees and reeds, when the zooecium dies down, to start life again in the spring by budding. Examples of these are also shown.

Some Polyzoa, besides statoblasts, produce also from fertilized ova ciliated and free-swimming larvæ. Some of these, derived from *Plumatella fungosa*, have been beautifully mounted by Mr. Hurrell, of Great Yarmouth, and show the double embryo growing within the larval form before it becomes fixed. I have also here a slide of young *Plumatella fungosa* emerging from the statoblasts, and these are always single polypides.

I have here brought together the statoblasts of all the species I have in course of time come across. Of these there are eight British species, one comes from Cape Colony, one from Rhodesia, one each from America and Germany, two from India, and three from Japan.

List of Statoblasts of Fresh-water Polyzoa.

| | | | |
|---|---|---|---|
| 1. | *Lophopus crystallinus* | From | England. |
| 2. | *L. capensis* | ,, | Cape Colony (Valkenburg Vlei). |
| 3. | *L. carteri* | ,, | India (Bombay Presidency). |
| 4. | *Lophöpodella Thomasi* | ,, | Rhodesia. |
| 5. | *Cristatella mucedo* | ,, | England. |
| 6. | *Pectinatella magnifica* | ,, | Hamburg. |
| 7. | *P. burmanica* | ,, | India (Igatpuri Lake). |
| 8. | *P. Davenporti* | ,, | Japan. |
| 9. | *P. gelatinosa* | ,, | Japan. |
| 10. | *Stephanella hina* (Oka) | ,, | Japan. |
| 11. | *Plumatella repens* | ,, | England. |
| 12. | *P. fruticosa* | ,, | England. |
| 13. | *P. punctata* | ,, | Dundee. |
| 14. | *Plumatella* sp. (?) | ,, | South Australia. |
| 15. | Ditto | ,, | Surrey Commercial Docks. |
| 16. | *P. tanganyikæ* | ,, | Lake Tanganyika. |
| 17. | *P. fungosa* | ,, | Hadley Wood. |
| 18. | Ditto | ,, | Surrey Canal. Young emerging. |
| 19. | Ditto | ,, | H. E. Hurrell. Free-swimming ciliated larvæ. |
| 20. | *Fredericella sultana* | ,, | Great Yarmouth. |
| 21. | *Paludicella articulata* | | Winter buds, or "hibernacula." |
| 22. | *Plumatella* or *Alcionella* | | Sessile statoblasts. |
| 23. | *Paludicella articulata* | | "Hibernacula" bursting open. |

**Dr. S. F. Harmer, F.R.S.,** who, on the invitation of the President, opened the discussion, said that, in the first place, it might be noted that fresh-water Polyzoa were a very difficult study, because of the great variability which occurred in them. If one collected a number of samples of fresh-water Polyzoa from different localities, great difficulty would be experienced in sorting them into their species. And one thing which had added to the difficulty was the divergence of opinion with regard to their proper nomenclature. In a comparatively recent monograph, Professor Kraepelin, of Hamburg, had, rather gratuitously, added to the complication by summarily throwing overboard all the old names. On the ground that *Plumatella repens* and certain other names had been used in such a variety of senses that it was almost impossible to know what was meant by them, Kraepelin proposed that they should be rejected in favour of new names of his own. Unfortunately, Dr. Harmer had noticed a tendency on the part of recent writers to adopt the names suggested by Kraepelin, which are contrary to all the recognized principles of nomenclature.

The statoblast is essentially an adaptation to fresh-water, and, as Mr. Rousselet said, is quite unknown in marine representatives of the group. Here and there in literature one found statements to the effect that objects comparable to statoblasts had been discovered in marine Polyzoa. But, so far as he knew, not one of those statements would bear critical examination; and he thought it might safely be assumed that statoblasts were structures entirely confined to the fresh-water members of the group. Perhaps their nearest analogues were the gemmules of fresh-water sponges. Their object was, in one respect, a very obvious one; they were (in these latitudes) for the purpose of enabling the organism to get through the winter, and to germinate in the following spring. Physiologically, they bore considerable resemblance to the seeds of flowering plants. One of their great peculiarities, as Mr. Rousselet had said, was that they floated on the surface of the water, and that led to one or two somewhat remarkable results.

He thought it was true of fresh-water Polyzoa that they were not, as a general rule, found in water which was flowing swiftly, if indeed they were found in such water at all. Anything floating on the surface of the water was liable to be carried down stream, and it would be difficult for a fresh-water Polyzoon to maintain itself in a stream in which the current flowed rapidly in one direction. He might refer to a locality where there was a pond which formed a lateral diverticulum of a river which always flowed in one direction; and he knew that if he went to that pond in any ordinary summer he could find fresh-water Polyzoa, whereas he did not find any in the river a few yards distant.

There was another point which had struck the attention of various observers. Statoblasts are liberated in the autumn, and float on the surface of the water, where they remain till the spring, at which season they germinate. They were thus exposed to the rigours of the winter; and if the water froze, the statoblasts would naturally be included in the ice. This point had been investigated by Braem, who had published evidence tending to show that the germination of statoblasts was distinctly improved by frost. This is probably not a universal rule about statoblasts; it was possible for them to germinate without having under-

gone this process. Still, it seemed reasonable to suppose that any structure such as statoblasts which floated on the surface must be adapted to this particular possibility; hence it is reasonable to believe the general correctness of Braem's results, that the fact of statoblasts having been enclosed in ice might have a beneficial effect on their germination in the following spring. It is probably not unlike what happens in a seed or a bulb, which becomes dry, and has to be left in a dormant condition before it is in a position to germinate.

There is no doubt that statoblasts are structures of the greatest importance for the distribution of the species. Streams would naturally wash the statoblasts towards the sea, and this could be counteracted by statoblasts being brought into the upper reaches of the river. That was a point on which further evidence was needed. There were one or two isolated records of statoblasts having been recovered from the mud attached to the legs, feet and beaks of aquatic birds; and all such records were of interest, and should be carefully preserved. This seemed one of the most probable ways in which a new place could be colonized with statoblasts.

There was a further point to which he would like to draw the special attention of Fellows. Fresh-water Polyzoa were, as far as he knew, unique in respect of the number of their reproductive processes. It was common in the animal kingdom to find two different methods of reproduction occurring: one the sexual method, by fertilized eggs; and the other the asexual method. And there were many cases in which there was a distinct alternation of generations, such as the Hydrozoa, by eggs and by budding. As a general rule, budding resulted in an increase in the number of individuals of a colony, but not in the production of a new colony. In fresh-water Polyzoa one found a remarkable phenomenon. Mr. Rousselet said that some of the Polyzoa produced ciliated larvæ; and he thought that gentleman might have made the statement general. In addition, there was the asexual production of statoblasts taking place simultaneously with the production of other buds which increased the number of individuals of the colony. These statoblasts, when they germinated, also gave rise to new colonies.

There was one further complication, namely, that there were two distinct kinds of statoblasts: ordinary statoblasts, which had a ring of air-cells enabling them to float: and sessile statoblasts (without the ring), which were produced at the base of the colony, and remained adherent to the substratum on which the colony had been growing when the colony disintegrated in the autumn. So there were three distinct kinds of reproductive body: ovum, ordinary summer statoblasts, and winter statoblasts. One of the things about which one would like more information was, What was the relationship between these various reproductive bodies? Was there any difference between the colonies which were produced by the fertilized ovum, and those which were produced by statoblasts? Also, was there any difference between colonies produced from sessile statoblasts, and those produced from floating statoblasts? It seemed to him that this was a subject which would well repay careful experimental work; and he did not think the difficulty of the investigation would prove at all insuperable. It would be possible to isolate particular statoblasts, and to expose them to conditions of various kinds,

and to find out exactly what happened. To take a particular case, there were two forms, which had been referred to distinct genera, *Plumatella* and *Alcyonella*. *Plumatella* grew in a diffuse way, with large spaces between the branches, and it could frequently be found under the leaves of water-lilies. *Alcyonella* formed large compact masses on the object on which it was growing, and its tubes were closely packed, standing vertically to the surface and in close lateral contact. It had been said that if cut in half old colonies presented a structure similar to that of an onion, due to the presence of several annual rings; and that this was due to the fact that at the end of the season the soft parts disintegrated, leaving the tubes, which contained a number of statoblasts. In the following spring the statoblasts which were left in the old tubes germinated, the junction of the new growth and of the old tubes forming an annual ring.

It has been considered that *Plumatella* and *Alcyonella* are different forms of one and the same species; that if one statoblast germinates on a leaf it grows out into the diffuse pattern which generally occurs in *Plumatella*; while, if a number of statoblasts are deposited close together in one place, the new colonies produced by their simultaneous germination have not sufficient room and the tubes are crowded, thus giving rise to an *Alcyonella* colony. The doubt that exists in this case (and in others) might be resolved by experimental work.

He would like to call attention to a point of some practical importance, namely, that there might be danger in throwing away in a sink living statoblasts. There were cases on record in which Polyzoa had made their way into pipes for the supply of water, where they had flourished in an extraordinary way, causing all kinds of difficulties which it was extremely difficult to get over. The Polyzoa are animals which can grow well in pipes containing unfiltered water in which there are diatoms. In Hamburg and other places they have given rise to serious trouble in the pipes supplying the houses with water. He did not suppose there was much danger of introducing them into the pipes of waste-systems, but as there was a possibility of infecting surface-water systems, it would be well to exercise care on this point.

**Mr. Earland** said that no one could look at such a collection of statoblasts without recognizing that some, at any rate, bore a strong superficial resemblance to the mysterious bodies known as Xanthidia, which were found in flints. Was it anything more than similarity of form? Years ago he had been interested in Xanthidia and made a collection of them. He came to the conclusion that they had originally been of a horny nature because many specimens were ruptured and showed ragged edges at the fracture. Did Dr. Harmer think there was any connexion between the objects other than the similarity of form, which was especially noticeable in *Cristatella* and *Pectinatella*? Of course, the fact that the chalk flints were of marine origin was a strong argument against any such connexion, but, on the other hand, he had himself found fresh-water statoblasts in marine shore-gatherings from the Clare Island area, and the bodies in chalk flints might conceivably have been derived from a cretaceous fresh-water polyzoon.

**Mr. D. J. Scourfield** expressed his gratitude to Mr. Rousselet for bringing before the Society such a fine collection of statoblasts,

embracing, as it did, nearly all the known forms. There was one specimen exhibited which was not really a statoblast but the hibernaculum of *Paludicella*, and it was a very interesting point as to whether there was any connexion between hibernacula and true statoblasts. In a paper dealing with the Polyzoa of water-works, published in the Proceedings of the Zoological Society three years ago, Dr. Harmer went into this question, and concluded that there was ground for thinking that both might be looked upon as internal buds which had evolved along somewhat different lines. His own contribution to the exhibition was a mass of statoblasts of *Cristatella*, which were taken from one of the reservoirs of the East London Water-works, where enormous numbers had occasionally been found floating at the margin. The specimens shown had remained in the bottle since 1900; he did not know whether they still retained their vitality, but proposed to test them before long. London water, he believed, was remarkably well filtered and free from microscopic organisms, but in some parts of the country this was not always the case, and under those circumstances Polyzoa being provided with the necessary pabulum were enabled to develop in the pipes.

**The President** made some observations on the Auxiliary Polypides discovered by Metchnikoff and Nitsche, and the account given of them by Hincks. He asked Dr. Harmer whether he regarded the record of statoblasts of marine Polyzoa by Joliet to be a sound observation.

**Dr. Harmer**, in replying, admitted his ignorance of Xanthidia, but he thought the answer to Mr. Earland's question was the one which he gave himself; that it was very improbable he would find, in a marine deposit like chalk, anything comparable with statoblasts of fresh-water Polyzoa, even making allowances for the possibility of the remains of fresh-water organisms being included in a marine deposit. Chalk is a deposit in which one would not expect to find fresh-water organisms; and if any organism were common in flints, one would find very great difficulty in supposing it had anything to do with essentially fresh-water Polyzoa.

In answer to the President's remarks, he confessed he had never himself found anything in marine Polyzoa which there seemed the least reason for associating with statoblasts. Conceivably there might be something which was homologous with these bodies, but he did not know of anything of the kind.

With regard to the possibility of comparing anything in the nature of polypides with statoblasts, that in itself seemed to him improbable. The polypide is the alimentary canal *plus* the tentacles and other organs of an individual unit of the Polyzoa colony. The rest of the individual is the outer body-wall surrounding the body-cavity containing the polypide. The statoblast has, in its early stages, no trace of polypide, but it is comparable with the body-wall of a single individual of the colony.

# VI.—*Alien Oligochæts in England.*

By The Rev. Hilderic Friend, F.R.M.S.

(*Read January 19th*, 1916.)

Figs. 1–6.

## *Kerria rubra* sp. n.

Whenever plants introduced from abroad have soil attached to their roots there is the possibility that young worms or cocoons may be present. Under suitable conditions these may develop, and in time become prolific. It is reasonable to suppose that in many cases the young die, and the cocoons fail to yield up living forms; but we have a number of records, based on more or less careful observation, to show that not a few alien Oligochæts have during recent years found their way to this country. Kew is naturally the place where the largest number of aliens have been found, and both Beddard and myself have placed on record at various times the results of our work on the Annelids of Kew Gardens. Elsewhere the species which have been most frequently reported are *Pheretima* (*Perichæta*) *indica* Horst, which is, as

---

EXPLANATION OF FIGURES.

The Roman numerals refer to the number of the segment.

Fig. 1.—Transverse section through segment 7, showing the arrangement of the setæ, thickened septa, glands, œsophagus, and nephridia.
,, 2.—Longitudinal vertical section through segments 8–15, showing gonads, œsophageal glands, girdle, and extended intestine.
,, 3.—Longitudinal section through spermathecæ.
,, 4.—Transverse section through segment 9, with glands opening into the œsophagus.
,, 5.—Longitudinal section through the anterior portion, to illustrate the shape and position of the brain.
,, 6.—Longitudinal section through girdle segments, with prostates and male pore.

Abbreviations:—*at.* attachment of brain; *b.c.* buccal cavity; *br.* brain; *b.v.* blood-vessel; *d.* dorsum; *d.v.* dorsal vessel; *gir.* girdle; *int.* intestine; *int.e.* intestinal enlargement; *l.s.* lateral setæ; *m.* muscle; *m.p.* male pore; *n.c.* nerve-cord; *neph.* nephridium; *œs.* œsophagus; *œs.gl.* œsophageal gland; *o.f.* funnel of oviduct; *os.* ovisac; *ov.* ovary; *ph.* pharynx; *p.p.* prostate pore; *pr.* prostomium; *ps.* prostates; *sep.* septum; *sep.gl.* septal gland; *s.f.* sperm-funnel; *sp s.* sperm-sac; *spth.* spermatheca; *t.* testis; *v.* venter; *v.s.* ventral setæ; *v.v.* ventral vessel.

Michaelsen remarks, "durch Verschleppung nahezu kosmopolitisch," and *Microscolex phosphoreus* (Ant. Dugès), also a "vielfach verschleppte Art." It is probable that if the various specimens hitherto reported under these two headings were subjected to a critical examination, it would be found that several species have been recorded under one name.

My reason for this statement is based on the fact that my most recent researches show that our alien Annelid fauna is very little known. From many parts of the country collections have reached me which show that a good deal of work remains to be done, and if a systematic examination of all the worms found at Kew, Chelsea, Oxford, Cambridge, Edinburgh, as well as in those districts in which foreign bulbs and other plants are grown under glass or in market gardens, we should add greatly to our knowledge of an interesting and useful subject. In support of this statement, I propose to submit details of a new species of Oligochæt worm found in this country. It is of more than ordinary interest because it is the first time that any representative of the genus has been found in Europe.

## I.—Historical Survey.

The genus *Kerria* was created by Beddard in 1892 (*1*).* "Mr. J. Graham Kerr," he writes, "who accompanied the Pilcomayo Expedition in 1890, has kindly given me a number of small Oligochæta which he collected in the upper reaches of that river. . . The water where they were met with was exceedingly salt and bitter, but contained a number of other animals, notably a few decapod Crustaceans. So far as I am aware, no Oligochæte of any kind has ever been described from a locality like the present, except a species of *Pachydrilus*, referred to by Semper as occurring in the brine-springs of Kissingen in Germany. Salt water is not, however, entirely inimical to the existence of Oligochæta, for there are a few species known from the sea-shore." After describing the worm, the writer concludes that "it will be necessary to institute a separate genus for this Acanthodriloid worm from the Pilcomayo, and I propose to call it *Kerria*, after Mr. Graham Kerr, with the specific name *halophila*."

Perhaps no one has done more to extend our knowledge of the genus than Rosa, whose various contributions to the Bulletins of the Turin Museum (*7*) may be consulted with advantage. We owe to him the discovery of some half-dozen species of *Kerria*, in or about 1895, while Eisen (*3*) and Michaelsen (*5*) have still further extended our knowledge of the genus. Beddard's Monograph (*2*) shows that four species of *Kerria* had been recognized in

* The figures within brackets refer to the Bibliography at the end of the paper.

1895. Five years later Michaelsen (*6*) tabulated no fewer than eleven, and two other species have since been added to the list. The present form, therefore, brings the known species of *Kerria* to fourteen.

## II.—Distribution.

As already stated, the first species, *Kerria halophila* Bedd., which forms the type, was found in salt water in the Pilcomayo. Later research has added many South American, West Indian, and Californian localities to the list. Mention may be made of Buenos Ayres, Uruguay, Southern Brazil, Paraguay, Valparaiso, Juan Fernandez, and San José del Cabo. The species are not all found in salt or brackish water, but flourish also in fresh water and in soft ooze or mud. Michaelsen summarizes the matter thus:—"Terrestrisch, im Süsswasser und in salzhaltigem Wasser. Subtropisches Süd-Amerika und Nieder-Californien." It is, therefore, clear that when the genus is found represented in England it cannot well be indigenous.

## III.—Generic Characters.

Though Beddard did not summarize the generic characters in his original description, he supplied a definition in his Monograph, which reads as follows:—

"Setæ paired, present on all the segments of the body except seta 2 on segments XVII and XIX of some species. No dorsal pores. Nephridia paired. One pair of testes in X. Spermiducal glands lined by a single layer of cells; no penial setæ. Spermathecæ with or without diverticula."

The difficulty with this definition is that it leaves one in doubt about the allied genera, as the author himself realized. "Very little is wanted," he writes, "to convert the (type) species into an *Ocnerodrilus*," while "it undoubtedly agrees in all those points which are made use of to define the genus *Acanthodrilus*. . . If it were not for the position of the calciferous (œsophageal) glands, all the resemblances between this worm (the type of the genus *Kerria*) and *Ocnerodrilus* might fairly be set down to a convergence due simply to degeneration."

The researches of Rosa made it possible to enlarge and define the generic characters with greater exactitude, and Michaelsen (*6*) was able in 1900 to give the following as the definition of *Kerria*:—

"Männliche Poren am 18 Segm.; Prostataporen 2 Paar, am 17 und 19 Segm.; Samentaschenporen meist 2 Paar, auf Intersegmtf. 7/8 und 8/9, selten die vorderen fehlend, 1 Muskelmagen im 7 Segm. oder keiner; 1 Paar seitliche Œsophagealtaschen im

9 Segm., meist einfach, selten mit nephridialen (?) Elementen verbunden. 2 Paar Prostaten (selten verdoppelt) münden getrennt von den Samenleitern aus; 1 Paar Hoden frei im 10 Segm. (Hoden bei wenigen Arten nicht beobachtet). Samentaschen meist ohne Divertikel, selten mit Aussackungen am distalen Ende der Ampulle (Divertikel?)."

Possibly further research will show the need of a modification of this definition. As at present understood, we find the genus including species which show widely divergent characters, such as the presence or absence of a gizzard, diverticula to spermathecæ, pigmentation, etc. The spermathecæ may be either one or two pairs, and the two pairs of prostates may be doubled. On the other hand, in some cases the gizzard is rudimentary, and so acts as a bridge between the species which possess one and those which are destitute of that organ: and the definition as set out by Michaelsen makes it impossible to remain in doubt whether or not a given species should be called *Acanthodrilus*, *Ocnerodrilus* or *Kerria*, as was the case in earlier days. Indeed, *Ocnerodrilus* has now been raised to a sub-family of which *Kerria* is one of the genera.

## IV.—Description of *Kerria rubra* sp. n.

Two years ago, while on a visit to Oxford, I found in the Lily House at the Botanic Garden a species of worm which I had not previously seen. It lived in the oozy mud which surrounded the plants on one side of the tank, and was accompanied by *Pheretima* (*indica*?). Unfortunately, it proved so tender and susceptible to adverse influences that when I reached home it had perished, and the relics were beyond recognition. I had, however, assured myself that, whatever the worm might be, it had never been recorded for this country, even as an alien. I therefore availed myself of the earliest opportunity which presented itself of again visiting the Garden, in the hope of obtaining further material. Though the creature was not abundant, I had the good fortune on June 21st, 1915, to secure two adults, and it is upon these that the following observations are based.

*External Characters.*—*Kerria rubra* is a very slender, delicate worm, extending while alive to two or three inches in length, but contracting to about 1½ in. in alcohol. It does not exceed 2 mm. in its greatest diameter, which is in the region of the girdle. The colour is red in the living worm, but the pigment disappears when it is preserved, and the region behind the girdle is so transparent as to admit of the nephridia being readily seen as large white convoluted bodies. It closely resembles a slender specimen of *Helodrilus oculatus* Hoffm.

The number of segments is about ninety; the setæ number eight,

and are arranged in four pairs, which are disposed as shown in the illustration (fig. 1, *l.s.*, *v.s.*). The girdle extends from the 13th to the 20th segment, and a pocket lens reveals very slight

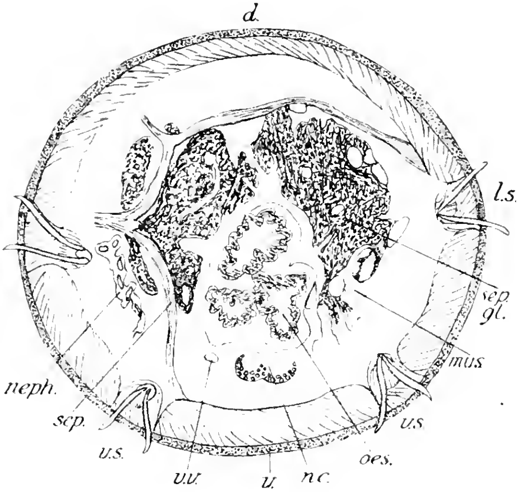



FIG. 1.

prominences on segments 17, 18, 19 ventrally. Sections show that these are related to the prostates and male pore. The girdle is saddle-shaped, but appears to cover a good part of the ventral

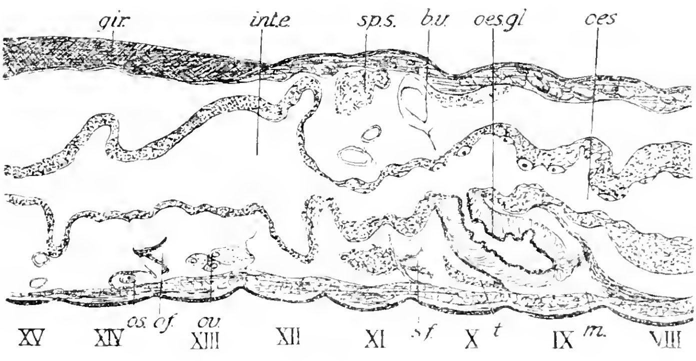



FIG. 2.

surface in a perfect adult. The illustration (fig. 2, *gir.*), shows it developed on the dorsal surface only. The shape of the head was not observed in the living worm. The anus is terminal.

M 2

*Negative Characters.*—In studying this species it soon becomes apparent that certain familiar characteristics of many Annelids are wanting. If one is examining the adult worm, whether living or preserved, it is impossible to detect the presence of dorsal pores. The same is true when sections are carefully scrutinized. As I found other aliens in Oxford which possessed such pores, this first

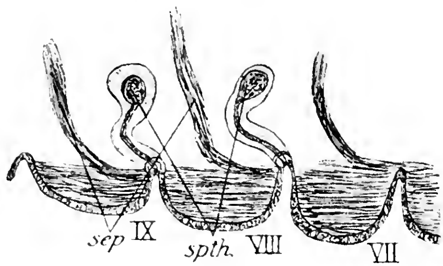



FIG. 3.

point of difference proved very arresting. There were, further, no signs of specialized setæ, such as are frequently found in foreign Oligochæts.

Coming to the internal structure, we find the following noteworthy negative characters:—

There are no diverticula to the spermathecæ; these are not

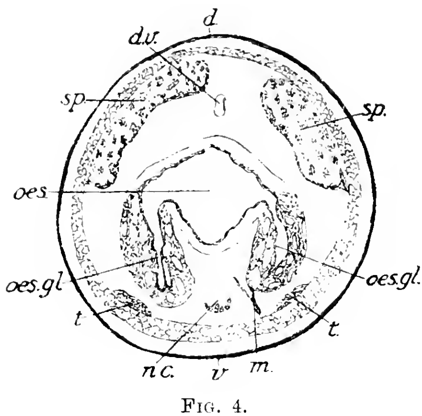



FIG. 4.

attached to the intestine, nor do glands exist at the opening. The worm is devoid of peptonephridia (salivary glands), and it has no cœlomic corpuscles or chloragogen cells. There is no tongue or taste organ, nor do prostrate papillæ present themselves in any noticeable fashion on segments 17 and 19. Calciferous glands are

wanting, their place being taken by a pair of ventrally-disposed œsophageal glands. This species, moreover, possesses no gizzard.

A further marked peculiarity is the absence of nephridia from the 11th and 14th segments. Beddard says of the type, that "The nephridia are present in the genital segments ; the posterior set are invested by a thick layer of peritoneal cells."

Altogether, the negative characters are important and instructive, and it would be helpful if in future those who described new species drew attention to these points.

*Internal Characters.*—As the sexual organs are of prime importance, it will be well if we study them first. It will then be possible to pass on to the other features of interest.

The *spermathecæ* are paired, and open (in harmony with the

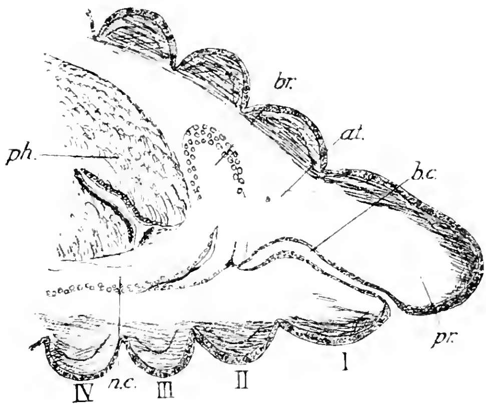



FIG. 5.

type) in the intersegments 7/8 and 8/9. They occur in segments 8 and 9, are destitute of diverticula and glands, and lie unattached in the cœlom. Though the worms were found in England, it was quite clear that the processes of reproduction were going on, for the spermathecæ were packed with spermatozoa. The twist of segments and the angle at which the sections were cut made it at first somewhat difficult to determine the exact shape of these organs. The illustration (fig. 3) is based on the study of a complete series of sections.

The *spermiducal orifices* are on the ventral surface of segments 17 and 19, the papillæ being inconspicuous. As is the case with the type, so here "the glandular tube is lined by a single layer only of cells." In this respect the genus agrees with typical *Ocnerodrilus*. The tubes or ducts go back at least as far as segment 21, beyond which my longitudinal sections do not carry me.

The diameter of the lumen does not exceed one-fifth that of the duct. The glandless portion is short, and may be said to equal in length the thickness of the girdle (fig. 6, *p.p.*) on the venter.

One pair of *testes* is found in the tenth segment (fig. 2, *t.*) attached to the posterior side of septum 9/10. In the same segment, attached to the anterior portion of septum 10/11, is a pair of funnels. Two pairs of sperm-sacs occupy the 10th and 11th segments, but the anterior pair pushes forward (fig. 2, *sp.s.*) into segment 9. The position of the testes and sperm-sacs agrees with that of the type.

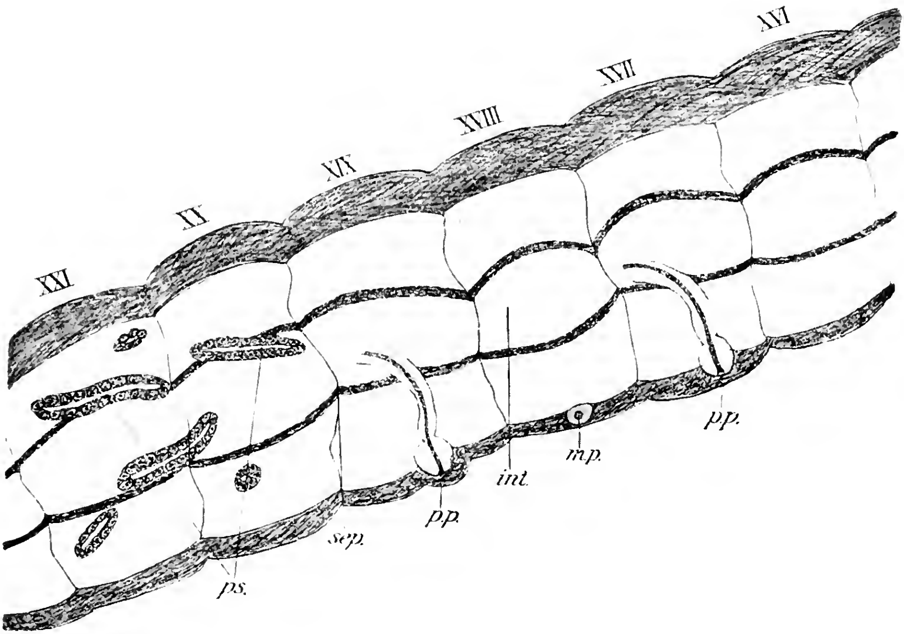



Fig. 6.

The *ovaries* are seen (fig. 2, *ov.*) to be situated in segment 13, and funnels or oviducts are attached to the anterior of septum 13/14, while ovisacs are found in segment 14. In the type described by Beddard no ovisacs occurred.

The *male pores* are on the ventral surface of segment 18, but I have been unable to trace the duct from segment 10. The pores do not lie in the same plane as those of the prostates.

*Kerria rubra* possesses no peptonephridia, or salivary glands. The ordinary nephridia commence in the 7th segment, and are found in all the remaining segments except 11 and 14. In the

worm preserved in alcohol they can be seen behind the girdle as a pair of large white convoluted bodies. In section some portions have an appearance which recalls the "flames" in the nephridia of Enchytræids.

The *alimentary system* presents several points of interest. The intestine widens greatly in segment 12 (fig. 2, *int.e.*). Attached to the ventral side of the œsophagus in the 9th segment is a pair of glands which in structure exactly resemble those of *Henlea fragilis* Friend (*4*). The illustrations (figs. 2 and 4) show them to be securely attached to the posterior surface of the strengthened intersegmental septum 8/9. These organs were known to Beddard as "calciferous pouches," but Michaelsen designates them "Chylustaschen." They are pear-shaped, and open directly into the œsophagus. There is no trace of the "nephridial element" here, which has been doubtfully recorded for some other species. There is also no gizzard.

The *septa*, or mesenteries, in some of the anterior segments, as is very frequently the case, are thickened. This applies in a marked degree to 6/7, 7/8, and 8/9, and in a lesser measure to 4/5, 5/6, and 9/10. Some of these septa are displaced, being thrust back so much that later septa become greatly crowded. The septal glands extend between the 4th and 8th segments, their maximum development being dorsal in segments 5, 6 (fig. 1, *sep.gl.*).

The nervous system does not require any special attention. The shape of the brain could not be seen in the living worm, but its contour has been reconstructed by means of a series of longitudinal vertical sections (fig. 5). I have not found it possible to give a detailed account of the vascular system. Sections, however, seem to indicate the 11th segment as the one in which the blood-vessels assume their largest development (fig. 2, *b.v.*).

## V.—Relative Position of *Kerria rubra*.

The various species of *Kerria* may be arranged according as they have or have not diverticula to the spermathecæ, double or single prostates, copulation papillæ, one or two pairs of spermathecæ, pigment in the body-wall, and a rudimentary or fully-developed gizzard, as against the absence of a gizzard, and the existence or otherwise of ovisacs, as well as by sundry other features.

As we have seen, *Kerria rubra* possesses no diverticula to the two pairs of spermathecæ. The prostates are not doubled, and there is no gizzard, but an ovisac is present, and the creature is red. If, now, we tabulate the characters of those species of *Kerria* which show these peculiarities, we shall be able to judge which of

them our present species most nearly resembles. To take the most important organs first:—

Two pairs of spermathecæ are found in the majority of species, opening in the intersegments 7/8, 8/9. One pair only occurs in *K. macdonaldi* Eisen. Copulation papillæ exist in *K. papillifera* Rosa, *K. stagnalis* (Kimb.), and some others. A small or rudimentary gizzard (Muskelmagen) is found in *K. garmani* Rosa, *K. saltensis* Bedd., *K. rosæ* Bedd., *K. macdonaldi* Eisen, and *K. eiseniana* Rosa; it exists in *K. kükenthali* Mich., and is well developed in *K. asunscionis* Rosa, *K. halophila* Bedd., *K. subandina*, while none is found in *K. stagnalis* (Kimb.), *K. papillifera* Rosa, and *K. rubra* Friend. But *K. stagnalis* and *K. papillifera* have muscular papillæ on segments 17 and 19 where the prostates open, whereas these are usually wanting in other species, including *rubra*.

Emphasis is laid by some systematists on the position of the external pore of the spermathecæ. If we name the setæ from the ventral to the dorsal *a, b, c, d*, then the spermathecæ may be said to open in a line with *a, b, c* or *d*, or between any two of these. Thus the spermathecæ of *K. subandina* open midway between setæ *c* and *d*, whereas in *K. halophila* (Beddard's type species) the opening is in the line *a b*. In this respect *K. rubra* is unlike the foregoing, but approaches *K. macdonaldi* and *K. eiseniana*, whose spermathecæ open immediately below *c*, but in each of these the spermathecæ differ from those of *K. rubra*.

*K. rubra*, therefore, occupies a position of its own, and it is on this account, perhaps unfortunate, that we have no means of knowing its original home. It may be possible to assign a place to *K. rubra* by following Michaelsen's classification.

| | | |
|---|---|---|
| 1 | Prostate opening through muscular papillæ | 2 |
| | Opening of prostate simple | 3 |
| 2 | Girdle forming a complete ring | 1. *K. stagnalis* |
| | Girdle saddle-shaped | 2. *K. papillifera* |
| 3 | Prostate doubled | 3. *K. zonalis* |
| | Prostate single | 4 |
| 4 | Spermathecal pores in line *a b* | 5 |
| | Spermathecal pores in line *c d* | 6 |
| 5 | Girdle ring-shaped, 14–19 segments | 4. *K. halophila* |
| | Girdle weak ventrally, 13–20 segments | 5. *K. asunscionis* |
| 6 | Spermathecæ with outgrowths | 6. *K. macdonaldi* |
| | Spermathecæ bottle-shaped | 7. *K. rubra* |

In the three last species the girdle is on segments 13–20, and the spermathecæ of *K. asunscionis* resemble those of *K. rubra*. But while in *K. rubra* the gizzard is absolutely wanting, and in *K. macdonaldi* at best rudimentary, in *K. asunscionis* it is fully developed.

We may tabulate the results thus :—

| Organs. | *Asunscionis.* | *Macdonaldi.* | *Rubra.* |
|---|---|---|---|
| Spermathecal opening . . . | In line *a b* | In line *c d* | In line *c d* |
| Gizzard . . | Present | Rudimentary | Absent |
| Spermathecæ . | Pear-shaped | With outgrowths | Pear or bottle-shaped |
| Girdle . . . . | Saddle-formed, 13–20 segm. | Saddle-formed, 13–20 segm. | Saddle-formed, 13–20 segm. |
| Prostrate . . | About 1 mm. long | Thin and short | Extending back to 21st segm. at least |

## Bibliography.


1. 1892. Beddard—P.Z.S., pp. 355–61.
2. 1895. ,, Monograph of the Order Oligochæta.
3. 1893. Eisen—Pro. Cal. Acad., ser. 2, iii. p. 294, *et seq.*
4. 1915. Friend—Annals of Applied Biology.
5. 1908. Michaelsen—Zool. Jahrb., Suppl. 11, Heft. i. pp. 24–5.
6. 1900. ,, Das Tierreich.
7. 1895. Rosa—Boll. Mus. Torino, x. No. 204.

# VII.—*Amstutz Optical Micrometer.*

By Marshall D. Ewell.

(*Read January* 19, 1916.)

Fig. 7.

In the practice of microscopy, the ability to measure thicknesses of sections, etc., by means of a graduated fine-adjustment in parts of a micron has meant much in setting the bounds for a most exact science; likewise the use of an ocular micrometer, filar or otherwise, has been of inestimable assistance in establishing definiteness of lineal dimensions. So far, however, it seems that little, if anything, has been done to make use of a definite dimensional scale combined with the folding elements of a single-lens pocket magnifier suitable for field work, and a multitude of other purposes, when magnifications of the order of about 13 diameters are used.

Such a magnifier has been devised by Mr. N. S. Amstutz,

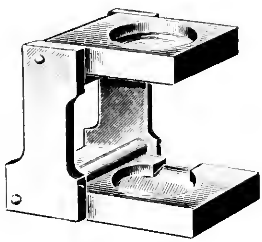


Fig. 7.

Research Engineer, of Valparaiso, Indiana. It is built much more stocky than the well-known French type of linen-tester. They are made in two forms—a $\frac{1}{2}$-in. opening and a $\frac{1}{4}$-in. opening, selling respectively at £1 and 12*s.* 6*d.*, post paid, including a leather case. The lenses are ordinary double-convex of about 0·8 in. focus. At the low magnification used it is scarcely found necessary to have an achromatic or aplanatic lens. The scales lie directly on the object being examined, hence the spherical aberration of an uncorrected lens is the same for the scale and the object, making the error of no practical moment. As the scales are in contact with the object there is no serious parallax error. The scales are ruled on brass strips which are secured on a bevelled seat sloping toward the actual centre of the lens. Different rulings

are being furnished for different trades. For instance, for photo-engravers an "$E^2$" scale is made having two groups of fine lines at 0·002″ (500 per in.), separated from each other $\frac{1}{10}$ in. so as to make it relatively easy to count any uniform divisions or screen-lines. Outside of and between the groups the main divisions are $\frac{1}{100}$ in., and indicated in fives for convenience of counting. Among other scales, some are ruled in metric dimensions, the smallest divisions usually being $\frac{1}{10}$ mm. It is a remarkable convenience to be able to make definite lineal measurements in this manner of microscopic objects. There is no trouble whatever to estimate the $\frac{1}{1000}$th part of an inch by means of the finest inch divisions, as it simply involves dividing one of the spaces into two parts. The sizes of half-tone dots can readily be determined. These glasses are being made at Valparaiso, Indiana, U.S., where Mr. Amstutz's son, F. W. Amstutz, is associated in their manufacture.

## VIII.—*Prolegomena towards a Study of the Progress and Development of Vision and Definition under the Microscope.—(1673–1848.)*

By E. Heron-Allen, F.L.S. P.R.M.S., and Charles F. Rousselet, F.R.M.S.

(*Read February* 16, 1916.)

In one of the opening paragraphs of the Charter granted to this Society by Her Majesty Queen Victoria in 1868, it is recited that "the great and general interest now felt in those branches of Science whereof the Microscope is an important instrument of investigation has been greatly promoted and fostered by this Society," and the first of the "Objects" of the Society, as stated in our By-law No. 1, is "the communication, discussion, and publication of Observations and Discoveries relating to Improvements in the Construction and mode of Application of the Microscope." No apology, therefore, is needed for our endeavour to put before the Society this evening a practical demonstration of the manner in which as a body we have executed the Trust confided to us by our Charter—a demonstration which we have little hesitation in saying that we are in a better position to give than any other scientific institution. We owe that position to the public spirit and enthusiasm of three generations of Microscopists who have gradually formed in our cabinets one of the finest collections of ancient Microscopes that has ever been got together. It had been our intention to preface this demonstration with a short historical account of the instrument from the earliest times to the present day, but it became immediately obvious to us that a subject which suffered from compression in five voluminous lectures thirty years ago * could not be dealt with in the time at our disposal at an ordinary meeting of the Society in 1916. All we can do, therefore, is to refer our Fellows to the Cantor Lectures of John Mayall already mentioned, to the papers of Dr. Charles Singer published in our Transactions † and in the Proceedings of the Royal Society of Medicine,‡ to the Catalogue of our Microscopes exhibited in the British Science Section of the Franco-British Exhibition of

* J. Mayall, Jun., "Cantor Lectures on the Microscope," London, 1886.

† C. Singer, "The Dawn of Microscopical Discovery," Journ. R. Micr. Soc., 1915, pp. 317–40.

‡ C. Singer, "Notes on the Early History of Microscopy," Proc. R. Soc. of Medicine (Sect. Hist. of Med.) vii. (1914) pp. 247–79.

1909,* and the elaborate descriptions of the instruments in the Society's collection contributed to our Proceedings over a long period by the Curators of Instruments, Mr. Charles F. Rousselet and his predecessors. Mention may also be made here of the many valuable papers contributed for over eleven years to the Society's Journal by Mr. E. M. Nelson. Side by side with these records may be studied the fascinating work upon "The Early Naturalists," by Professor L. C. Miall, F.R.S.,† who desires us to express to the Society his regret that he is unable to be present this evening, and take part in our demonstration and discussion.

But we wish to lay emphasis upon the fact that our object in laying this paper before you is more far-reaching in its intent than the occupation of a single meeting of the Society. Our object is in the main to give a practical demonstration of the desirability, nay, the necessity for the promotion and publication by this Society of a comprehensive history of the Microscope from the earliest times to the present day. We have no hesitation in saying, and we say it without fear of contradiction, that this Society is well equipped for the task, both as regards knowledge and material. It is a matter of common knowledge that the private collection of our some-time Secretary, Sir Frank Crisp, is one of world-wide celebrity, and that many instruments of unique historical interest are in the hands of other Fellows both past and present. The technical skill and scientific knowledge of Messrs. Nelson, Gordon, Cheshire, Rousselet, and the historical researches of Dr. Charles Singer, are, we have reason to know, at the service of the Society for the furtherance of the object which we have in view, and with such treasures of knowledge and material at our disposal there can be no doubt of the successful accomplishment of an authoritative and definitive work. The admirable work of Harting ‡ is sealed to those who do not read Dutch with ease, though it should be noted that there is a German translation of Harting's work, by Dr. Fk. Wilh. Theile (Braunschweig, 1859). The work of Landsberg § remains unfinished; whilst those of Petri ‖ and Rocchi ¶ are necessarily circumscribed by their media of publication.

The Royal Microscopical Society's History of the Microscope is therefore a clearly-indicated necessity, and we trust that this

* Royal Microscopical Society's Microscopes at the Franco-British Exhibition, Journ. R. Micr. Soc., 1909, pp. 651–60.

† L. C. Miall, "The Early Naturalists, their Lives and Work: 1530–1789," London, 1912.

‡ P. Harting, "Het Mikroskoop, dwzelfs gebruik, geschiedenis en tegenwoordige toestand," Utrecht, 1848–50, 3 vols.

§ C. Landsberg, "Central. Zeitung für Optik. und Mechanik," 1890, p. 272.

‖ B. J. Petri, "Das Mikroskop," Berlin, 1896. (Introduction.)

¶ V. Rocchi, "Appunti di Storia Critica del Microscopio," Riv. Storia Crit. d. Sci. Mediche e Nat., 1913, Ann. iv. p. 1.

evening's demonstration will stand recorded in our Proceedings as the point of departure for its publication.

Between Seneca's globe of water in the 1st century A.D.* (through which "letters though small and indistinct, are seen enlarged and more distinct,") and the prismatic binocular of Conrad Beck lies a long road, diversified by steep acclivities and precipitous descents, by fertile plains and sterile chasms, and there is no lack of rocks to be surmounted and pit-falls to be avoided.

A long and illuminative series of early books is exhibited to-night, in which not only the instruments used, but the objects seen are illustrated in historical sequence. It has been said that "the earliest illustrated publication for which there is any evidence that a magnifying glass was used is by Hofnagel and appeared at Frankfort in 1592." † The magnified domestic fly from that work has been reproduced in our Journal,‡ but nearly thirty years before that, Conrad Gesner illustrated § an organism *Strombus lapidus*, which the late Prof. T. Rupert Jones identified as the Foraminifer *Vaginulina lævigata*; ‖ this work is on the table to-night.

We will detain you no longer, but will call your attention shortly to the instruments exhibited this evening. Mr. Court emphasizes the fact that during the 17th, and the earlier part of the 18th century, on the Continent, and in France and Germany in particular, scientific instruments were often engraved with elaborate designs, decorated with fancy scrolls, and embossed in gold on vellum and leather. Microscopes and scientific instruments generally of this description have often survived, being preserved from destruction on account of their artistic value, when they had been superseded by better and later models from a practical point of view. The instruments made in Great Britain were generally of a plainer description, and would therefore, when their usefulness had passed away, be either destroyed, or altered by the addition of newer devices and improvements, by which their original characteristics were disguised and obscured, and their historical value greatly impaired. This no doubt accounts for the scarcity of the earlier forms of Microscopes made in Great Britain during the 17th century.

The series of instruments shown on the table to-night have been selected from the cabinets of the Society with the view of illustrating, so far as possible, the gradual improvement of the

* Seneca, "Quæstiones Naturales," Bk. i. Ch. vi.

† "Archetypa studiaque patris Georgii Hoefnagelii," Frankfort, 1592.

‡ J.R.M.S., 1915, p. 318.

§ C. Gesner, "De omni rerum fossilium genere, gemmis," etc., Tiguri, 1565. (Last section, p. 165.)

‖ T. Rupert Jones, Quart. Journ. Geol. Soc., 1884, pl. xxxiv. fig. 5.

microscopical image as shown under low powers, and we are indebted to Mr. T. H. Court and Mr. George H. Gabb for the loan of interesting and rare types which were not in the Society's collection. No doubt several other models could have been profitably included, but they have been omitted because, as is unfortunately often the case, *contemporary* objectives were not available for use with the instruments. In order to facilitate the comparison of the image in the different instruments we have in every case exhibited the same organism, the common Foraminifer *Polystomella striato-punctata* (Fichtel & Moll). We have chosen this, not only because it is a suitable object for medium powers, but also because it was one of the first Rhizopoda ever figured,* appearing in the "Micrographia" of Hooke in 1665,† and in the Letters of Professor Plimmer's "Immortal Beadle,"‡ Antony van Leeuwenhoek,§ the former "from small sand," the latter "from the stomach of a shrimp." The slides have been mounted, by Mr. Arthur Earland, in various methods contemporary with the Microscopes employed.

## Class I.—The Early Type of Simple Microscope.

### 1. *Antony van Leeuwenhoek* (c. 1673).

This is a copy made for Sir Frank Crisp from that in his possession, and presented to the Society by him, the original being in the Zoological Laboratory at the University of Utrecht. (See Journ. R.M.S., 1914, p. 105.) Two thin metal plates are fastened together by rivets. Between these plates a very small double convex glass lens is mounted between two concavities provided with minute apertures. The object is held in front of the lens on the point of a short pin, the other end of which screws into a small block or stage of brass, which is riveted on the end of a long coarse-threaded screw acting through a socket angle-piece attached behind the lower end of the plates. It is with such instruments, of the rudest kind mechanically, that Leeuwenhoek astonished the world with his discoveries of Infusoria, Bacteria, and other microscopic forms of life.

Described and figured in Mayall's Cantor Lectures, 1885, p. 20, in Journ. R.M.S., 1886, pp. 1047–9; 1909, p. 652, and 1914, p. 105; and Singer, Proc. Roy. Soc. Med., vii. 1914, p. 252.

* L. C. Miall, Op. cit., p. 140.

† R. Hooke, "Micrographia," etc., London, 1665, p. 80, pl. v. fig. 10.

‡ H. G. Plimmer, "*Bedellus immortalis*," Journ. R. Micr. Soc., 1913, p. 121.

§ A. van Leeuwenhoek, "Sevende Vervolg der Brieven, Waar in gehandelt werd van veele Opmerkens en verwonderenswaardige Natuurs-Geheimen," Delft, 1702, p. 195, pl. (opp. p. 191), fig. 7, *a*, *b*, *c*, "Vertoont een van de Slak-hoorntjens die bij mij uit de Maag van een Garnaad is genomen."

The object is quite recognizable, although the definition is extremely poor. This lack of definition is probably due to the fact that the model-maker concentrated his skill on the reproduction of the metal work and neglected the reproduction of the lens.

2. *Wilson's Screw-Barrel Microscope* (1702).

Two specimens of this instrument are exhibited, the one showing its adaptation to the examination of transparent objects, the other, its use with opaque objects. In the one case the object-slide is held by a spiral spring and focused by a screw-barrel, which also carries an illuminating lens. At the further end, in the other case, a rod, provided with forceps, replaces the object-slide, and a lens-carrying arm enables the magnifier to be suitably placed for viewing an object held by the forceps. This was a very popular model during the 18th century. (See Phil. Trans. xxii. pp. 1241–7.)

Described and figured in Journ. R.M.S., 1905, p. 740.

The progress of vision and definition is of course inseparably connected with the development of substage mirrors, condensers, and diaphragms. These are indicated in Hooke's Microscope in 1665, and Bonanni in 1692 shows the first compound focusing substage condenser, whilst in 1693 John Marshall, here in England, had supplied a substage condenser to his Great Double Microscope, consisting of a convex lens at the end of a pointed arm which could be adjusted up or down if required. In 1694 Hartsoeker figures a single convex lens focusing by a screw, and in the Microscope we are now showing there is a fixed convex lens, not capable of focusing or adjustment.

3. *Joblot's "Troisième Nouveau Microscope"* (c. 1716).

This instrument, which is the only one of its kind known to us, is of very decorative and elaborate workmanship, but it is unfortunately not in working order. Joblot's Microscope had a substage diaphragm lined with black velvet which he called the "canon." (See Journ. R.M.S., 1914, p. 297.)

4. *Lieberkuhn's Microscope, invented* 1738, *made by Benjamin Martin about* 1762.

This is a simple biconvex lens, mounted in the central aperture of a polished metal reflector, which formed a small hand-Microscope for the special purpose of viewing opaque objects. This construction, in an improved form and applied to achromatic object-glasses, is in use at the present day. (See Adam's "Micrographia Illustrata," 1747, p. 16, and Journ. R.M.S., 1909, p. 652.)

It is only applicable to objects mounted in the special Lieberkuhn manner. The definition is admirable, but the image is, of course, very small.

## Class II.—The Old Compound or "Double" Microscope.

The Compound Microscope, as at first constructed, consisted of a single eye-lens, and a lens that did duty for the objective. About 1663 the field-lens was first added and soon became general. About this time also Microscopes were made with compound eye-pieces and compound objectives, but they did not survive, or at any rate become general, and it was not until 1759, when B. Martin added the extra lens at the back of the objective, that any improvement was made in the optical part of the instrument in its dioptric form.

### 5. *John Marshall's "Double Microscope,"* 1690.

The points to be noted in the instrument exhibited, which is of earlier date than the one in the Society's collection, are (i) the provision of a screw for fine focusing, and (ii) the clamping of the stage to the pillar. The ball-and-socket joint at the base of the square pillar is typical of the earlier models; in the later instruments the ball-and-socket is replaced by a rigid pillar and a mirror is added below the stage. The instrument was described in the original advertisement of it as "John Marshall's New Invented Double Microscope for Viewing the Circulation of the Blood." The word "double" here signifies that it was a compound instrument, provided with an objective for forming an image of the object and an ocular for viewing the image so formed. Concerning this instrument see Mayall's Cantor Lectures, 1885, p. 37. This instrument has been lent us for exhibition this evening by Mr. George H. Gabb, a member of the Quekett Microscopical Club.

In 1702, Zahn in his "Oculus artificialis" (p. 796) shows what is probably the first Microscope with diaphragms.

### 6. *Culpeper's Compound Microscope* (ante 1738).

This is a modification of Wilson's simple Microscope. A body-tube of ivory, with draw-tube, is provided for the purpose of transforming it into a compound instrument, which is mounted on a pillar with a ball-and-socket joint.

(This instrument is described and figured in Mayall's Cantor Lectures, 1885, p. 34. See Journ. R.M.S. 1909, p. 653.)

The definition is very fair.

### 7. *Culpeper's Microscope*, improved by Scarlet (c. 1725).

This tripod form of Microscope stand, mounted on a wooden box, was a favourite model for more than a century. It was copied and made by successive opticians with many variations in form, material, and finish until about the middle of last century. The body of the present model is made of wood and cardboard, and the focusing is done by sliding the body. There is no fine-adjustment. The object-glass is a single biconvex lens, and the eye-piece has two lenses. A mirror with ball-and-socket motion is fixed to the box foot. These makers placed a conical ivory diaphragm below the stage to cut off part of the light under certain conditions.

This instrument is described in R. Smith's "Opticks" (Cambridge, 1738), ii. p. 407, and figured in Mayall's Cantor Lectures, 1885, p. 40. (See Journ. R.M.S., 1909, p. 654.)

No improvement in the definition.

### 8. *Nathaniel Adams' Microscope* (c. 1740).

This is of the Culpeper and Scarlet pattern, and is rendered even more unhandy by the addition of a fourth pillar in the space surrounding the stage. This inconvenience was incurred, no doubt, for the sake of the greater rigidity secured by the fourth pillar—a distinct advantage in focusing the instrument. Attention may be drawn to the elaborate chain of ball-and-socket joints by which a condensing lens is connected to the stage. (See Journ. R.M.S., 1905, p. 397; and 1909, p. 654.)

The concave mirror is fixed, and it is consequently very difficult to obtain satisfactory illumination. There is no change in the definition.

### 9. *George Adams' "New Universal Single and Double Microscope"* (c. 1746).

This Microscope has a folding tripod base, from which rises an octagonal pillar, bored out to receive a cylindrical stem that slides telescopically within it. The stem carries an eight-lobed disk or "scalloped plate," as Adams terms it, containing eight biconvex lenses of graduated powers. The disk can be rotated beneath a fixed wheel so that any lens can be brought into use, whilst all the others are protected from dust by the flat rim, anticipating by 130 years the modern dust-proof, rotating nose-piece. The body is made of blackened and polished ivory. The coarse-adjustment is effected by releasing a pinching screw at the

back of the pillar, and raising or lowering the stem to the required position, which is shown by index numbers on the octagonal pillar; the screw is then tightened up, and an object mounted on a slide placed on the stage will be in focus. The fine-adjustment is actuated by the milled head of a micrometer screw at the base of the pillar.

Though not inclinable and very light it shows important improvements over the Microscope of the period, and its workmanship is excellent in every detail. (For description and figures see Journ. R.M.S., 1909, p. 633–6.)

This instrument gives a notably large amount of colour in the image.

## Class III.—Compound and Simple Microscopes Combined.

### 10. *John Cuff's "New Constructed Double Microscope"* (c. 1744).

The inventor of this model made a distinct improvement in the mechanical construction of the Microscope, and it forms an important link in the evolution of the instrument. The stand is firmer and more rigid, and altogether more handy, whilst the stage is more accessible; the fine-adjustment applied to the body has greater delicacy. Cuff added the Lieberkuhn to the compound Microscope, fitting it in such a manner that it could be used with all the objectives, and his method was to all intents the same as that employed to the present day.

Described by Baker, "Employment for the Microscope," 1753, pp. 442–6. (See Journ. R.M.S., 1904, p. 727; and 1909, p. 655.)

### 11. *John Cuff's Single Aquatic Microscope* (c. 1750). (*Lent by Mr. Thomas H. Court.*)

Compared with its predecessors the present instrument shows distinct improvements. The following points may be noted:— 1. It is provided with a fine-adjustment which focuses the lens, not the stage. 2. The instrument is inclinable. 3. The pillar is mounted eccentrically on its oval base-plate, and is capable of rotation, which gives the Microscope greater stability when used in an upright position. 4. It can be folded for portability. This model is interesting as being the original form of aquatic Microscope as first made by Cuff. At the suggestion of John Ellis, F.R.S., it was altered to form what is now known as the Ellis Aquatic Microscope, and in this form it was used by him in 1752, whilst he was writing his work on the Corallines, published in 1755.

Upon the lines of the Ellis Aquatic Microscope, nearly all later models of dissecting Microscopes were fashioned. Owing to the careful way in which the lenses are worked and mounted, and the fine-adjustment supplied, it is possible to get a very good image with this Microscope. (See Journ. R.M.S., 1898, p. 675; and 1909, p. 654.)

### 12. *Benjamin Martin* (c. 1760).

The maker of this instrument devised numerous improvements in the mechanism and optical arrangement of the Microscope, and the present model is an important link in its development. For the first time there is a slow and fine movement for focusing, by rack-and-pinion and by screw, both applied to the stage, with the constant action of a spring to check the motion. A small compass-joint at the top of the pillar allows the carrying-ring to be turned out of the way when the instrument is used as a simple Microscope. (See Journ. R.M.S., 1900, p. 269; 1909, p. 655.)

This model is very interesting as, optically speaking, it differs from any of the previously described Microscopes. The eye lens is double (which gives a larger and flatter field), being composed of two double convex lenses; there is the usual field lens, and, in addition, at the top of the nose-piece, there is a small biconvex lens of about 5 in. focus, which can be used with any of the object-glasses, and really forms a back combination for all of them. Mr. Nelson has pointed out in an article describing a very similar Microscope in his possession that the action of this lens by reducing the power and increasing the aperture increases the optical index, and consequently improves the Microscope. This important improvement was later adopted by all the leading opticians, and is found in most of the better-class Microscopes till the advent of the achromatic form in 1826.

### 13. *Benjamin Martin's "Large Universal Microscope"* (c. 1771).

This exceedingly elaborate instrument, of exquisite workmanship, with every conceivable movement, is said to have been made for King George III. The meaning of the word "universal" is that it can be used for viewing opaque or transparent objects with either a single or double lens combination, that is to say, either as a simple or as a compound instrument, and that it possessed, in addition, the joints and accessories necessary to enable the user to direct his gaze in a horizontal, vertical, or inclined direction at his choice, and to carry the body of the instrument over the different parts of the stage by what was then called the "aquatic"

traversing motion. The triangular upright stem has a compass joint at its base, and is fixed to an elaborate foot, over which it is adapted to rotate. This foot is, in most descriptions of the instrument, erroneously described as a tripod. The three feet do not, in fact, support the instrument, but serve only to steady it, the weight being carried by the knob in the middle of the foot. The stage has micrometric movements in three directions; it moves the object over a wire scale in the eye-piece. This method of micrometry was invented by Benjamin Martin, who also wrote a book about it. The double mirror, as well as the stage, can be raised and depressed by rack-and-pinion. The compound body can be removed and replaced by a simple Microscope; the stage also can be removed and replaced. Provision is made for holding and illuminating living objects and large opaque specimens.

This Microscope is fully described in the Transactions of the R.M.S. of 1862, p. 31. (See also Journ. R.M.S., 1909, p. 656.)

The definition is improved by the back lens, and there is no "fog" as in other contemporary instruments. The substage condensers of Martin mark a great step in the progress of the instrument.

### 14. *Benjamin Martin's "New Universal Microscope"* (c. 1776).

The stem inclinable by a joint at its base, where it is fixed to a folding tripod foot. The body is attached to a movable arm, which, in turn, is carried by the stem. This arm can be swung about the axis of the stem, and moved to and fro in its socket, these movements facilitating the exploration of a large specimen. In consequence of this adaptation such Microscopes were, in the latter half of the 18th century, called "aquatic." Focusing is effected by rack-and-pinion, which moves the stem and body, whilst the stage is fixed. This Microscope has a rotating multiple lens-carrier nose-piece, invented by Père Cherubini d'Orléans.

Described and figured in Journ. R.M.S., 1899, p. 325.

The improvements to this instrument are merely mechanical, the optical construction not differing in any important particulars from No. 12 before described. The adjustable pillar seen here was first used in Watkins' Microscope (1754). The back lens is absent and the definition is very poor.

### 15. *Shuttleworth's Microscope* (c. 1786).

The stand of this instrument is a somewhat later imitation of the Benjamin Martin type. The triangular stem has a compass-joint at its base, by means of which the whole Microscope is

inclinable. The stage has rack-and-pinion focusing movement. The body is fixed to a movable and rotating arm, and carries François Watkins' rotating multiple lens-carrier nose-piece. The mirror and condensing lens slide on the triangular pillar.

Described and figured in Journ. R.M.S., 1908, p. 365; and 1909, p. 657.

The definition is not bad, the back lens introduced by Martin making a slight improvement. Beyond this there is no special feature or improvement.

### 16. *Jones's "Most Improved Microscope"* (c. 1798).

This model follows an earlier form of François Watkins, inasmuch as the compass-joint making the Microscope inclinable is raised to the top of an upright stem, fixed to a tripod folding foot. To the joint is fixed a square limb, on the top of which a short arm, movable by rack-and-pinion, supports the body of the Microscope. The stage moves on the limb by rack-and-pinion, which serves for the focusing of the object. The mirror and condensing-lens slide on the same square limb. The object-glasses are contained in a rotating multiple lens-carrier nose-piece.

The instrument was described by its makers (W. and S. Jones, of Holborn) as the "most improved" Microscope. This instrument does, in fact, represent the culminating point reached by the dioptric instrument before the introduction of the achromatic objective.

Described and figured in Adams' "Essays on the Microscope," 2nd ed., 1798, p. 99. (See Journ. R.M.S., 1909, p. 657.)

The definition in this particular specimen is poor, and there is a good deal of colour. A double mirror is attached to a separate rod. The earliest known Microscope with a double mirror dates from 1748.

## Class IV.—Reflecting Microscopes.

Although Robert Smith had invented his reflecting Microscope in 1738, with a condensing lens in front of the stage, the Microscope when in use being in a horizontal position, it did not come into general use, neither did that of Barker (1736), which was also of the reflecting type. With these exceptions the optical construction and definition did not vary till the introduction of Woollaston Doublet and the Chevalier Doublet in 1820–30. Of course differences of definition and field are found, owing to the manner in which the lenses were ground and mounted, the most careful workmanship naturally giving the best results.

### 17. *Amici's Reflecting Microscope* (c. 1827).

This Microscope is achromatic, and there is therefore a distinct improvement in the definition and in the image. (See Journ. R.M.S., 1609, p. 120.)

### 18. *Cuthbert's Reflecting Microscope* (c. 1827).

The attempts made at the close of the 18th and beginning of the 19th centuries to produce achromatic object-glasses for the Microscope having failed, owing to technical difficulties, the makers of these Microscopes attempted to produce achromatism by means of mirrors, carrying into effect a suggestion originally made by Newton, which one or two other makers had followed up. Cuthbert's instruments are said by Mayall to have been the best of their type. The magnification of objects is here effected by means of very small reflecting specula, and the result for low and medium powers was fairly satisfactory. The body is fixed by a compass-joint on the top of the telescopic stem supported on a folding tripod. The focusing is effected by moving the stage, and the latter has rectangular motion.

Described and figured in Mayall's Cantor Lectures, 1885, p. 58. (See Journ. R.M.S., 1909, p. 657; and 1913, pp. 98–100.)

Cuthbert's reflecting Microscope was said by contemporary users to have been a great improvement on Amici's type. The instrument requires some adjustment; it is suggested that very likely the figure of the mirror has been spoiled by repolishing at some time, but this cannot be ascertained without making a thorough test.

## Class V.—Achromatic Microscopes.

### 19. *Dellebarre's "Microscope Universel" (Uncorrected)* (c. 1777).

This stand is a French model on the lines of the English Microscopes of the period. The square limb is fixed on to a scrolled folding tripod foot, and has a hinge about its middle by means of which the upper part can be inclined. The body is fixed to an arm which slides in a rotating socket at the top of the limb. The concave mirror and condensing lens slide on the limb. The arm carrying the stage has a pinion moving in a rack cut in the limb for the purpose of focusing.

Dellebarre endeavoured to obtain achromatism by the use of oculars built up of crown and flint glass lenses, the excessive

correction of the ocular compensating for want of correction of the objective. His plan was not, however, successful, and the first practical achromatic Microscope was not produced until fifty years after his time.

Described and figured in Petri's "Das Mikroskop," p. 162. (See Journ. R.M.S., 1909, p. 658.)

The instrument is not in working order, the lens in the eye-piece being absent. Doubtfully achromatic.

### 20. *Charles Chevalier's "Microscope Achromatique"* (c. 1834).

The brothers Chevalier, of Paris, were the first opticians to produce, about 1823, practically useful achromatic object-glasses for the Microscope. The present instrument is an early specimen made by Charles Chevalier. The mechanical model followed is still that of Jones's "most improved," with various modifications. The arm carrying both the body and the limb is fixed by a compass-joint to the top of the stem, which itself is supported on a flat solid tripod. Focusing is effected by rack-and-pinion to the stage, which itself is mechanical in one direction only.

Described and figured in Chevalier's "Des Microscopes et de leur Usage," 1839, pp. 98–100, pl. 3. (See Journ. R.M.S., 1909, p. 658.)

The advance in definition is very marked, and when a balsam-mounted specimen is used the improvement is still more marked. Balsam mounts were, to all intents and purposes, unknown at this period, though Swammerdam (1637–1680) used balsam to render his anatomical preparations transparent. An account of his method is to be found at the end of Schrader's "Observationes et Historiæ" (Amsterdam, 1674). See also L. C. Miall, *op. cit.* p. 178.

### 21. *Charles Chevalier* (c. 1840).

This exceedingly well-made instrument is an enlarged and improved Microscope upon the model of the preceding, embodying a number of devices for use in an erect or in a horizontal position, and for the observation of chemical reactions. It is described by its maker as his "Microscope Achromatique Universel." The focusing arrangements, both coarse and fine, are still attached to the stage, whilst the body remains fixed. In the horizontal position a right-angled prism is used for deflecting the rays into the tube. The mirror is plane and concave, and is movable by rack-and-pinion. The whole Microscope is exceedingly steady, and all the motions very smooth.

"Described and figured in Chevalier's "Des Microscopes et de leur Usage," p. 88, pl. 4. (See Journ. R.M.S., 1909, p. 649.)

The definition in this instrument is hardly inferior to that of modern instruments with a 2-inch objective. The improvement upon earlier models is chiefly noticeable with the higher powers.

Chevalier added a set of rotating diaphragms, similar to those now in use, to his simple Microscope, which was modelled on Ellis's "Aquatic Microscope."

### 22. *Hugh Powell* (1839).

This Microscope is of very great interest, because it embodies new features which have now been very generally adopted in the design of the Microscope. The body, stage and mirror are carried by the limb, which itself is attached by a compass-joint to an upright telescopic pillar raised on a solid tripod. The coarse-adjustment by rack-and-pinion for the first time moves the body of the Microscope, but the fine-adjustment is applied to the stage by a wedge acted on by a micrometer screw. In this model also Hugh Powell systematically applied the method of "springing" in the movements to prevent loose action: its application to the pivots of the mirror can be well seen.

Described in Journ. R.M.S., 1901, p. 728: and 1909, p. 659.

It is of interest to note that the whole of P. H. Gosse's work on the Rotifera was done with a Microscope of this type, which he used throughout his life, "in spite of modern improvements."

From this time the definition of low-power objectives has altered very little. Until the introduction of the latest corrected and apochromatic objectives in recent years there was but little change, even in medium and high powers.

### 23. *Hugh Powell. Large Microscope* (1841.)

This almost too elaborate and substantial stand was considered the best of its day, and embodies all the most refined movements and apparatus the maker was able to devise. The body is moved by rack-and-pinion, and is attached to a hollow triangular bar. The fine-adjustment actuates the stage. Originally this was a monocular Microscope, but the binocular body with Wenham's prism was fitted to it after the invention of the latter in 1863.

Described and figured in Journ. R.M.S., 1900, p. 285; and 1909, p. 659.

### 24. *James Smith* (1841).

This stand has become a model on which many English stands have since been made. A substantial pillar mounted on a solid tripod supports a grooved limb, which itself carries directly the body, stage, and mirror. Coarse-adjustment is effected by rack-and-pinion moving the body, whilst the fine-adjustment for the first time by lever and screw acts on the nose-piece only. The mechanical stage has rectangular motion, and can be rotated.

Described and figured in Microscopic Journal, ii., p. 1, and in Journ. R.M.S., 1900, p. 553; and 1909, p. 660.

### 25. *Andrew Ross* (1841).

The pillar is mounted on a circular base, which rotates so as to increase the steadiness of the base when the Microscope is inclined. The body slides in the grooved limb, and the fine-adjustment acts by a lever on the nose-piece. The mechanical stage has rectangular movements and also rotates.

Described and figured in Journ. R.M.S., 1899, p. 214; and 1909, p. 660.

### 26. *Edwin Quekett's Microscope* (1844).

This instrument was designed and mainly constructed by Dr. Quekett, the founder of the Royal Microscopical Society. Whilst following James Smith's Microscope in general arrangement, this model is characterized by greater rigidity of the foot and pillar. The mechanical stage is made on A. Ross's pattern. Below the stage there is a focusing condenser. Bequeathed to the Society by Dr. Quekett, who died June 28, 1847.

(See Journ. R.M.S., 1909, p. 660.)

### 27. *Powell and Lealand* (1848).

This model is the first example in which the Microscope is hanging in a tripod, and is also the first example in which the fine-adjustment moves the nose-piece by means of a lever within a bar. The mechanical stage has Turrell's rectangular movement, and possesses a focusing condenser. This type of Microscope appears to have been first made in 1843, but, as in all the features mentioned it is being reproduced at the present day, it may be said to represent the modern instrument.

This instrument is described and figured in the Journ. R.M.S., 1898, p. 125; 1901, p. 727; and 1909, p. 660.

The Authors desire to record their great indebtedness to Mr. Thomas H. Court for his invaluable assistance, both in preparing the instruments for exhibition and in the preparation of this Paper; to Mr. Charles Lees Curties for adjusting and cleaning the instruments; and to Mr. Arthur Earland for mounting the objects exhibited.

# OBITUARY.

## Thomas William Butcher. 1868–1916.

Dr. Butcher was a graduate in Medicine of Edinburgh University, and after obtaining his degree he became a resident at a hospital, where he acquired considerable professional experience. He then settled down in practice at Blackpool. He held several medical appointments in that town, and for the last year or more of his life was Chairman of the Blackpool Insurance Committee, and for some time was President of the Blackpool Microscopical Society. In 1910 Dr. Butcher was elected a Fellow of the Royal Microscopical Society, and at the November meeting of the Society in the same year he gave a brilliant exhibition of photomicrographs of Diatoms, and described at length the conditions under which they were taken.

In October 1911 he read a paper before the Society, entitled "The Structural Detail of *Coscinodiscus asteromphalus.*" The paper is illustrated with sixteen photomicrographs.

That Dr. Butcher was in the front rank of photomicrographers is undoubtedly true. His work obtained universal recognition, and he was awarded several medals for the excellence of his photomicrographs.

# SUMMARY OF CURRENT RESEARCHES

RELATING TO

# ZOOLOGY AND BOTANY

(PRINCIPALLY INVERTEBRATA AND CRYPTOGAMIA),

# MICROSCOPY, ETC.*

## ZOOLOGY.

### VERTEBRATA.

#### a. Embryology.†

**Oogenesis in Chick.**‡—Charles H. Swift has inquired into the origin of the definitive sex-cells in the female chick and their relation to the primordial germ-cells. During the two days subsequent to the development of the germinal epithelium (between eightieth and ninetieth hours of incubation), a majority of the primordial germ-cells are found between the cells of that tissue. Some of the remaining primordial germ-cells are present in the mesenchyme beneath the germinal epithelium, others are found in the cords of urogenital union, still others remain in the root of the mesentery. The latter may be seen in that situation in some embryos until the ninth day of development, when they degenerate. During the fourth and fifth days of development it may be seen that the number of germ-cells on the left side exceeds that on the right in the proportion of 2–5 to 1.

During the sixth and seventh days of development the germinal epithelium sends down into the subjacent tissue a first series of sex-cords or cords of first proliferation. These cords are produced as a result of localized activity of the germinal epithelium. The cords of first proliferation are epithelial in character, and the germ-cells, which are present in them, do not seem to have anything to do with their formation. But it is possible that some germ-cells stimulate the epithelial cells around them to activity. The cords of first proliferation

* The Society are not intended to be denoted by the editorial "we," and they do not hold themselves responsible for the views of the authors of the papers noted, nor for any claim to novelty or otherwise made by them. The object of this part of the Journal is to present a summary of the papers *as actually published*, and to describe and illustrate Instruments, Apparatus, etc., which are either new or have not been previously described in this country.

† This section includes not only papers relating to Embryology properly so called, but also those dealing with Evolution, Development, Reproduction, and allied subjects.

‡ Amer. Journ. Anat., xviii. (1915) pp. 441–70 (8 figs.).

become seminiferous tubules in the testis, medullary cords in the ovary. When they are formed, it is possible to distinguish the sexes, for the number of primordial germ-cells remaining in the germinal epithelium after the formation of the cords of first proliferation is small in the male, and not greatly diminished in the female.

Beginning with the eighth, but especially during the ninth, tenth, and eleventh days of development, there is a rapid increase in the number of primordial germ-cells in the germinal epithelium of the female. Three or four dividing germ-cells may be seen in a small area. Collected into groups, which are the result of successive mitoses, the primordial germ-cells, or oogonia as they may now be called, give rise to lobulations which appear on the deep surface of the epithelium. These lobulations or buds, composed chiefly of oogonia, but including also cells of peritoneal parentage, increase in size and become the cords of second proliferation or cortical cords. The oogonia become definitive ova, while the peritoneal cells of the germinal epithelium, present in the cortical cords, develop the follicular epithelium.

**Intracranial Ganglion on Oculomotor Nerve of Dogfish.***—G. E. Nicholls has observed in three specimens of *Scyllium canicula* a small collection of ganglion cells associated with the oculomotor nerve. They are probably of normal occurrence, and oculomotor ganglia are known to be present, either as functional structures or vestiges, in widely separated vertebrate types. Since ganglia, other than sympathetic, are known to occur normally only upon "sensory nerves," or on the dorsal root of mixed nerves, the question arises: What is the significance of the occurrence of ganglia upon the oculomotor?

From the available evidence, which is somewhat indefinite and conflicting, three facts emerge: (1) that in the primordium of the oculomotor, cells are found derived by migration (*a*) from the medulla, and (*b*) from the neural crest; (2) that certain of these cells in the oculomotor primordium migrate into the primordium of the ciliary ganglion, precisely as do cells from a typical dorsal ganglion into a typical sympathetic ganglion; and (3) that the weight of evidence appears to be against the belief that cells of medullary origin contribute to the formation of sympathetic ganglia. The inference is that the cells which pass along the oculomotor to the ciliary ganglion must have been derived, in the first instance, from the neural crest.

The author seeks to establish the proposition that the oculomotor is not correctly viewed as the equivalent of a ventral root only. "Rather we must accept it as the homologue of a complete segmental nerve, containing elements of both dorsal and ventral roots, although some of these components have apparently become obsolete, and the distinction of the originally separate dorsal and ventral roots has disappeared."

The occurrence in the oculomotor of afferent nerve fibres (conducting centripetally impulses arising in sensorial end-organs), and of ganglion cells upon the root of the nerve almost certainly related to these afferent fibres, taken in conjunction with the part which this nerve plays in the

* Proc. Roy. Soc. B., lxxxviii. (1915) pp. 553–68 (1 fig.).

development of the ciliary ganglion, constitutes evidence in favour of the complete segmental character of the nerve too important to be ignored.

**Vascularization Phenomena in Blastoderm Fragments.***—F. P. Reagan has observed the development of fragments ("meroplasts") of embryonic bodies completely isolated from yolk-sac blastoderm prior to an "invasion" by the so-called yolk-sac "angioblast" (the origin of vascular tissue). After incubation for thirty to forty-eight hours such fragments were found to possess blood-vessels in varying degrees of development. It seems that the embryonic meroplast possesses an inherent capacity for differentiation which tides it over to the time when heart-pulsations would normally provide a means of tissue respiration. As the meroplasts develop legitimate vascular cavities with a good endothelium, an angioblastic origin of intra-embryonic endothelium cannot be argued for. The endothelium differentiates from an "indifferent" mesenchyme. The yolk-sac is not necessarily the site of formation of the earliest blood-vessels. Intra-embryonic vessels develop *in situ* when communication of extra-embryonic vessels with intra-embryonic tissue is prevented by chemical or mechanical means.

**Development of Sound-transmitting Apparatus in Necturus.**†—H. D. Reed has re-investigated this much-studied apparatus. It consists of a single plate that accurately fills the somewhat elliptical foramen vestibuli of the mature amphibian, and is connected by a well-defined stilus with the suspensorum of the jaws. But the fenestral plate, though of the single type, is double in origin. The columellar portion is extra-otic, having no early developmental connexion with the ear-capsule. At about the beginning of larval life it spreads out over the fenestral membrane, and completely fills the cephalic portion of the fenestra. From this position it gradually narrows, coming to a point and disappearing near the centre of the oval window. The remaining portion, by far the larger, of the fenestra is filled by tissue originating from chondroblasts in the fenestral membrane, and therefore strictly otic. The columellar portion, including the stilus, is the homologue of the columella of *Amblystoma*. The otic part represents the operculum. The larval characteristics of the plate are shown not in its structure, but in the absence of the musculus opercularis. As a whole, the apparatus in *Necturus* is morphologically intermediate between that of *Amblystoma* and that of Plethodontidæ.

**Experimental Production of Defective and Monstrous Development.**‡—E. I. Werber subjected eggs of *Fundulus* to the action of substances like butyric acid and acetone, which occur in the blood or urine of man during metabolic disorders. A great variety of monsters resulted, analogous and homologous with human and other mammalian monsters. The monstrosities concern the eyes (cyclopia, synophthalmia,

* Anat. Record, ix. (1915) pp. 329–41 (10 figs.).
† Anat. Record, ix. (1915) pp. 581–90 (6 figs.).
‡ Anat. Record, ix. (1915) pp. 529–62 (29 figs.).

monophthalmia asymmetrica, and anophthalmia), the ear-vessels, the olfactory pits, the mouth, the central nervous system, the heart and blood-vessels, the fins, and the form of the body.

A condition of hydrops was found in many embryos, due, apparently, to blood vascular abnormalities which might be considered as homologous with some forms of hydrocephalus in man. In many eggs parts of the embryonic material were destroyed, while the residue developed into anterior hemi-embryos or other meroplastic embryos. In some eggs one eye developed from a small fragment of a medullary plate independently of an embryo.

As to the mode of action of butyric acid and acetone, it is suggested that a process of blastolytic fragmentation is in some cases induced. Regarding the formation of the various degrees of the "cyclopean" defect, it is concluded that the fusion theory of Speeman and Lewis is justified in the main. An additional assumption is made, namely, that the blastolytic process which eliminates parts of the potential interocular or ophthalmoblastic material takes place at a very early stage of development, i.e. before the formation of the embryonic shield. The results obtained tend to justify the assumption that monstrous development may be due to metabolic toxæmia.

**Reproduction of White Rat.***—Helen Dean King and J. M. Stotsenburg note that breeding extends throughout the year in *Mus norvegicus albinus*, though the periods of greatest sexual activity are in spring and autumn. The sex ratio in 1,089 litters was 107·5 males to 100 females. There is apparently a seasonal variation in the sex ratio, for it is relatively low in litters cast in spring and early autumn, much higher in those cast in summer. Data for 75 litters produced by 21 albino females indicate that the sex ratio among the first offspring of young females is higher than among the offspring of the same females when they are at the height of their reproductive power.

There does not seem to be any relation between the size of a litter and the sex of its members. The average for 1,089 litters was seven, lower than for grey rats, higher than for black rats. There is no pronounced seasonal variation in the size of the litter comparable to the seasonal variation noted in the sex ratios. As a rule the first of an albino female's four litters is the smallest, the second and third are the largest, and the fourth is a little larger than the first.

**Growth of the Fœtal Albino Rat.**†—J. M. Stotsenburg has studied this on fresh specimens. Lowrey's study of the pre-natal growth of the pig and Jackson's study of human growth were based on preserved material. The rat fœtuses studied were all from second litters, normal behaviour having been exhibited in the first litter. The fœtus of thirteen days was found to be the youngest which would stand manipulation without damage, and the observations began with that age. They continued to the twenty-second day—about the time of birth. Thirty-three females were studied and 330 fœtuses weighed.

* Anat. Record, ix. (1915) pp. 403–20 (1 fig.).
† Anat. Record, ix, (1915) pp. 667–82 (2 figs.)

It has been pointed out by Donaldson that we may assume the span of life in the albino rat to be three years; and that this is equivalent to ninety years in man. On this assumption the rat grows thirty times as rapidly as man. The early stages of development in the albino rat go very slowly. In the growing fœtus the rate tends to diminish with age. The average weight of the fœtus is greater in the horn containing the smaller number. The diet of the mother appears to influence the number of offspring.

**Relative Weight-changes in the Organs of Young Albino Rats.*** C. M. Jackson has made an experimental study of the changes in the relative weights of the different parts, organs, and systems of young albino rats, kept at constant body-weight by under-feeding for various periods. He finds that young rats may be kept at constant body-weight for considerable periods by under-feeding, the amount of food necessary for this purpose decreasing as the experiment proceeds. The relative weights of head, trunk and extremities remain practically unchanged. There is apparently a slight increase in the head, counter-balanced by a slight decrease in the trunk and extremities; but the change is so slight that it seems of doubtful significance. There is little change in the weights of the musculature and the viscera as a whole. There is, however, a marked decrease in the weight of the integument, and a marked increase in the skeleton. Thus, on the low plane of nutrition in the young body maintained at constant weight, the growth capacity appears weakest in the skin and strongest in the skeletal system. This is in striking contrast with the normal growth process of corresponding ages, during which the musculature increases with relatively great rapidity, while the skeleton lags behind. The skeletal increase appears to involve the ligaments as well as the cartilages and bones. It tends to proceed along the lines of normal development, as indicated by decrease in the water-content, and by formation and union of various epiphyses. Another evidence of the tendency to normal development is seen in the increased relative length of the tail, as compared with the body-length. The teeth also continue to develop normally.

The individual viscera may be classified in three groups:—1. There is, during the maintenance of constant body-weight in young rats, a well-marked increase in the weights of the eye-balls, spinal cord, alimentary canal (both empty and including contents), testes, hypophysis, and supra-renal glands. The supra-renals undergo sexual differentiation in weight (as occurs normally), but the hypophysis apparently does not. 2. There is no marked change in the weight of the epididymis. The liver is variable, showing a definite increase in the earlier periods, but a decrease later. The lungs show a slight decrease in the earlier periods, but not in the later. There is a well-marked decrease in the weights of the thymus ("hunger involution") spleen, thyroid gland, and ovaries. When the organs are similarly grouped according to degree of loss during chronic inanition in the adult, many differences are found in comparison with the corresponding

* Journ. Exper. Zool., xix. (1915) pp. 99–156 (4 figs.).

groups in the young during constant body-weight. This is explained as due to the presence of both the growth tendency and the (more or less different) maintenance tendency in the young animals, whereas in the adult there is only the tendency to maintenance. Both the growth tendency and the maintenance tendency, however, show characteristic differences in the various organs according to nutritional conditions.

**Chorda tympani and Middle Ear in Reptiles, Birds and Mammals.***—E. S. Goodrich discusses the chorda tympani and middle ear in Reptiles, Birds and Mammals, with special reference to the exact relation of the chorda tympani to the first gill-slit, tympanum and surrounding structures. A comparison of the development of the various structures of the middle ear region in the lizard, duck and mammal shows a remarkable uniformity in their origin and relation. The first gill-pouch separates off from the epidermis from below upwards; at its dorsal edge is an epiblastic proliferation contributing to the geniculate ganglion. The tympanum is formed between the outer epidermis and an outgrowing diverticulum of the hinder lower region of the first gill-pouch. The chorda tympani is a post-trematic branch of the facial nerve, developing behind the first or spiracular gill-slit, and passing down to the lower jaw between the tympanum and the closing spiracle. The relation of these parts to the skeleton and blood-vessels is, except in gallinaceous birds, constant throughout the Amniota, and is only intelligible on the view of Reichert that the proximal region of the columella corresponds to the stapes, the quadrate to the incus, and the articular to the malleus. In the duck the chorda tympani develops as a pre-trematic branch of the facial nerve from its first appearance. In adult gallinaceous birds the chorda passes down directly from the geniculate ganglion in front of the tympanic cavity. This exceptional position is probably due to some secondary modification at present unexplained.

### *b.* Histology.

**Rôles of Nucleus and Cytoplasm in Melanin Elaboration.**†—Davenport Hooker discusses this question in the light of recent research. He presents an account of the relevant investigations. It appears that melanin may be produced from tyrosin, or its derivatives, acted upon by an oxidizing agent, tyrosinase. Free tyrosin occurs in horses with melanotic tumours, and derivatives of tyrosin are absorbed by the animal body. Lillie has shown that the nucleus of the cell plays a part as a producer of oxygen or of an oxidase. Tyrosinase is normally present in many parts of the body. In the case of the frog, specially investigated by the author, it seems probable that the base from which the melanin granules are formed exists in a soluble condition in the cytoplasm, that the rôle of the cytoplasm is as a carrier of the chromogen, and that the nucleus plays an all-important part.

The evidence goes to show :—(1) that the theory of the origin of melanin from chromatin extruded from the nucleus into the cytoplasm

* Quart. Journ. Micr. Sci., lx. (1915) pp. 133–60 (3 pls. and 5 figs.).
† Anat. Record, ix. (1915) pp. 393–402 (1 fig.).

is untenable, at least in the frog; (2) that the nucleus plays an essential part in pigment formation by some activity which greatly resembles an oxidizing action; (3) that melanin is formed in the cytoplasm of the cell at the point of known greatest efficiency of the nucleus as an oxidizing agent. More generally, in the cells of embryo frogs, melanin is formed from some substance (probably tyrosin or its derivatives) in solution in the cytoplasm when acted upon by the nucleus (perhaps an oxidase reaction).

**Permeability of Cells for Acids.***—E. Newton Harvey has used a pigment, "antedonin," which occurs in the epithelium of the viscera of a Holothurian, *Stichopus ananas*, as an indicator for the penetration of acids into cells. Living tissues are resistant to the penetration of all acids except salicylic, benzoic, and possibly valeric. The degree of resistance varies with the acid. The penetration rate of HCl is roughly proportional to the concentration. Dead tissues are readily permeable for all acids. There is no relation between the degree of dissociation of the acid and its rate of penetration, or between degree of association and toxicity. There is a general relation between penetrability and lipoid solubility and capillary activity, but it is not exact nor quantitative. The best relation is between penetrability and toxicity. The acids which penetrate most readily are most toxic, irrespective of their strength. Cells behave towards acids and alkalies as if they were droplets of a fat or fat solvent. This suggests that cells must be composed largely of fat-protein combinations, in which the visible physical characteristics of fat are masked.

**Structure and Polarity of Electric Motor Nerve-cell in Torpedo.**†—Ulric Dahlgren finds evidence that the plasmosome is the heaviest body in the nucleus, undoubtedly heavier in actual weight than the chromatin bodies, and probably of greater specific weight than any of the other nuclear organs, with the probable exception of the karyosomes. In the young fish the plasmosome seems to have a central or general distribution; in older or larger fishes it tends to be ventral. This is probably due to its increasing size and weight, together with a lessened resistance on the part of the nuclear-content to slow movement through the mass. Such movement of the plasmosome must depend largely upon growth changes and readjustment in the nucleus, which favour its passage through the achromatin. While very strong electric currents seemed to move the plastosome, weak currents did not influence it. Gravity seems to be the cause of the orientation of the plastosome.

**Trophospongia of Spinal Ganglion Cells.**‡—Emil Holmgren defends his conception of an internal granular-protoplasmic network within the ganglion cells. It sometimes reaches the surface of the cell, and may be connected with cellular elements outside—namely, with processes of the mantle-cells. Holmgren has made fresh observations on

* Papers Dept. Mar. Biol., Carnegie Inst. Washington, viii. (1915) pp. 145–56.

† Papers Dept. Mar. Biol., Carnegie Inst. Washington, viii. (1915) pp. 213–56 (6 pls. and 6 figs.).

‡ Arkiv Zool., ix. (1915) No. 15, pp. 1–26 (2 pls. and 2 figs.).

the spinal ganglion cells of the rabbit and the pigeon, and corroborates his previous results. He suggests that trophocytes absorb substances from the blood in the immediate vicinity of the spinal ganglion cells, and store them in their cell-substance in the form of material which is darkened by osmic acid. From the trophocytes the material may pass into the intracellular processes of the trophospongia, and has to do with the constitution of the tigroid substance. The canaliculi which sometimes take the place of the granular threads of the network are not artefacts. They become more numerous after prolonged and energetic stimulation.

**Structure of Adrenals of Amphibians.***—T. B. Magath corroborates in *Rana pipiens* and *R. clamata* the observation of Patzelt and Kubik on *R. esculenta* that there are two kinds of cells in the adrenal glands. There is an epithelial portion composed of the common lipoid-containing cells, and among them large granular acidophilous cells. There is, secondly, a chromaffine portion. Acidophilous cells appear in the adrenals all the year round, and Stilling's term "summer cells" is inappropriate. In addition to those Anura and Urodela noted by Patzelt and Kubik, there are no acidophilous cells in *Spelerpes bilineatus*, *Plethodon glutinosus*, and *Acris gryllus*. The presence of acidophilous cells in the adrenals of the three species of *Rana* named above may indicate close relationship and similar metabolism.

**Ampullæ of Lorenzini in Dogfish.**†—H. E. Metcalf has made an experimental and histological study of the ampullæ of Lorenzini in *Acanthias vulgaris*, and finds that they are primarily sense organs. They have a secretory function in so far as it is necessary to keep up the supply of mucus in the ampullæ and their ducts. This need is small, as there is little loss. The ampullæ respond to the stimulus of pressure, and if currents of water impinge on some of the ampullæ more forcibly than on others, the fish may get some indication of the direction of the source of the stimulus. The ampullæ may also serve as depth-indicators. The minute structure of the duct and ampulla is described.

The number of ampullæ varies from 1,200 to 1,900—about 500 dorsal, 900 ventral and anterior to the mouth, and 200 lateral and posterior to the mouth. There are none posterior to the first gill-slit. There is no addition to the number after birth.

### c. General.

**Transmission of Tropical Diseases.**‡—J. W. W. Stephens discusses the mode of transmission of some tropical diseases. Thus, malarial parasites are spread by Anopheline mosquitoes. Attention is directed to a recent case of malaria from Romney Marsh, to Indian villages which have no malaria though in the midst of intensely malarial districts, and to the reservoir of malaria afforded by native children who do not seem to be much the worse. Yellow fever, the organism of which is still

* Trans. Amer. Micr. Soc., xxxiv. (1915) pp. 154–8 (2 figs.).
† Trans. Amer. Micr. Soc., xxxiv. (1915) pp. 131–46 (2 pls. and 4 figs.).
‡ Proc. Trans. Liverpool Biol. Soc., xxix. (1915) pp. 3–19.

unknown, is transmitted by the bite of a mosquito, *Stegomyia fasciata*, which bites at night when adult, and is only dangerous twelve days after it has bitten an infected patient. Phlebotomous fever, or "three-days' fever," or "summer influenza," is transmitted by certain kinds of sandflies. Sleeping sickness, due to *Trypanosoma gambiense* and *T. rhodesiense* is transmitted by *Glossina palpalis* and *G. morsitans* respectively. The reservoir is in native game. European relapsing fever, due to *Spirochæta recurrentis*, is transmitted probably by lice. African relapsing fever, due to *S. duttoni*, is transmitted by ticks (*Ornithodoros moubata*). Bubonic plague is transmitted from rat to man by *Pulex cheopis*, the rat-flea. Elephantiasis, due to a Nematode (*Filaria*) is transmitted by mosquitoes. A number of other diseases are discussed.

**Identity of Heliotropism in Animals and Plants.***—Jacques Loeb and Hardolph Wasteneys have been led by experiment to this conclusion. They regard the heliotropic reactions of certain plants and animals as due to a chemical action of light. There seem to exist two types of heliotropic substances, one with a maximum of sensitiveness (or absorption) in the yellowish-green (near $\lambda = 534$ $\mu\mu$), and the second with a maximum of sensitiveness in the blue (near $\lambda = 477$ $\mu\mu$). Visual purple is a representative of the former type, and occurs in the Protozoon *Chlamydomonas* (often claimed as a plant), in *Daphnia*, and many other organisms. The photo-sensitive substance, with the maximal sensitiveness in the blue, is found in *Euglena*, in many plants, and in certain animals, such as *Eudendrium*. The two types of photo-sensitive substances are distributed independently of the systematic boundaries between plants and animals.

**Abnormality in Mandible of Chimæra.**†—W. E. Collinge describes a small plate-like bone, immediately behind the lower posterior border of the mandibular symphysis, in *Chimæra monstrosa*. In another specimen it had a median wedge-like portion, flanked on each side by a similar tapering piece. It is suggested that it may be a reversionary vestige of a presymphysial mandibular tooth which has got turned back. The minute structure of the abnormal bone is quite distinct from that of the ordinary bones of fishes. The nearest condition is the state of certain bones in post-larval Pleuronectids. There is a series of closely massed strands, forming a meshwork of spongy material.

**Organ of Jacobson in Insectivora.**‡—R. Broom describes the structure of the organ of Jacobson in *Talpa*, *Centetes*, and *Chrysochloris*, and his results, taken along with those reached in a previous study, go to show that the "Insectivora" do not form a natural order. In *Erinaceus*, *Gymnura*, *Talpa*, *Sorex*, and *Centetes*, the organ of Jacobson ends in a long duct opening into the naso-palatine canal near its anterior part. Jacobson's cartilage in each passes forwards with the duct, and the naso-palatine canal is supported by an anterior process of the posterior nasal-floor cartilage. Whatever subdivision may on other grounds be made of

* Science, xli. (1915) pp. 328–30.
† Ann. Nat. Hist., xxi. (1915) pp. 110-3 (4 figs.).
‡ Proc. Zool. Soc., 1915, pp. 347–54 (2 pls.).

these Insectivores, they all belong to the Cœnorhinata, and agree with most higher Mammals, such as Carnivores and Ungulates.

On the other hand, *Tupaia* and *Macroscelides* agree in having a Polyprotodont Marsupial type of structure, and cannot have any near affinity with the typical Insectivores; and the order Menotyphla, to which they belong, must be removed far from the Insectivora and placed in quite a different alliance, not far from the early Marsupials.

Although *Chrysochloris* has been generally regarded as allied to *Centetes*, it is not at all closely related to it. Like *Tupaia*, *Chrysochloris* belongs to the Archæorhinata, but it cannot belong to the order Menotyphla. The peculiar structure of the molar teeth of *Chrysochloris* has suggested an affinity with *Centetes*, but a similar type of molar occurs in the Marsupial *Notoryctes*, and the resemblance is probably one of convergence. The development of *Chrysochloris* must be inquired into, but in the meantime Broom has no hesitation in removing it from the Insectivora and placing it in a distinct order, for which the name Chrysochloridea, proposed by Dobson, may be retained.

**Penis of New-born Bear.***—Ed. Retterer and H. Neuville describe this in a brown bear's cub 18 cm. in total length. The cub was covered with hair, whereas Weber has described it as being born quite naked. The body of the penis includes an unpaired corpus cavernosum, a fibro-elastic envelope or fascia, and a corpus spongiosum. The glans and the adjacent part of the body of the penis had a corpus cavernosum formed of precartilaginous tissue of precisely the same structure as that of a newly-born dog. Later on there is formed an S-shaped bone. The particular point of the investigation is to show the resemblance between the dog type and the bear type in the structure of the penis, thus corroborating the conclusion of palæontologists that Cynoids and Arctoids had a common ancestor.

**Origin of Blind Fishes.**†—Jacques Loeb has found that embryos with degenerated eyes can be produced by heterogeneous hybridization, e.g. *Fundulus heteroclitus* ♀ and *Menidia*. In these cases there is usually no circulation, and this may account for the anomalous condition of the eye. Moreover, blind embryos of the pure breed of *F. heteroclitus* may be produced by the addition of KCN to the sea-water.

It is shown that immediately after fertilization (by sperm of its own species), and during the early stages of segmentation, the egg of *F. heteroclitus* is rapidly killed or injured if it is exposed to a constant temperature of about 0° C. (or slightly above); while it may be exposed to a slightly higher temperature (e.g. 7° C.) for weeks without being injured. If the egg is exposed to the low temperature after the embryo is once formed, it can resist the low temperature from 0° to 2° C. for weeks without permanent injurious effects. If eggs of *F. heteroclitus* are fertilized with the sperm of the same species, and exposed immediately after fertilization for a number of hours to a temperature

* C.R. Soc. Biol. Paris, lxxviii. (1915) pp. 327-30.
† Biol. Bulletin, xxix. (1915) pp. 50-67 (13 figs.).

of between 0° and 2° C., abnormal embryos can be produced, a certain percentage of which may show degenerate eyes.

Lack of light does not influence the development of the eyes of *Fundulus*, and Loeb inclines to the view that some internal mutational change in the germ, and not the lack of light, may account for the blindness of certain cave fishes and salamanders.

**Tentacles of Blenny.***—H. A. Baylis has studied the two pairs of branched tentacles (supra-orbital and nasal) on the head of *Blennius gattorugine*, and describes their minute structure—e.g. two forms of mucous cells, fusiform cells apparently connected with nerve-fibres, very large elongated cells which usually extend through the whole thickness of the epidermis. It appears that the tentacles are very sensitive to touch, whether the stimulus comes from an article of food or an inanimate object. It is possible that the tentacles are sensitive to disturbances in the water, but no evidence was forthcoming. C. Tate Regan suggests that they may serve to gauge the amount of space in the crannies.

**Habits of Cottus bubalis.**†—R. Elmhirst writes an interesting note on the habits, especially in relation to breeding, of *Cottus bubalis*, which he has had opportunities of observing in the tanks at the Millport Marine Biological Station. A female deposited eggs on a stone about the end of February, and the male after fertilizing them mounted guard over them and never went more than a few inches away from them for five or six weeks. No other male was allowed to approach the stone. No trace of nest-building by the male was observed. Later, a second female spawned on the same stone, and the male was observed in the act of fertilizing them. He was brilliantly coloured ; pale orange ventrally, pectoral fins white, spotted and blotched with colour. The fins twitched constantly as the male jumped and turned excitedly, and sometimes dashed under the stone below the female. In this position semen was ejaculated from the penis, which was protruded 11 mm. on to the egg-mass. The tentacles over the eye were very distinct and quivering, and the maxillary tentacle was very erect. Several times the male darted open-mouthed at the female and engulfed half her head in his mouth. The rate of the respiratory act was 36 per minute, and very full ; that of the female not so full. The normal rate varies between 28 and 32. A third female spawned on the same stone, and all three died within a few days of spawning.

**Lapillus of Fishes.**‡—C. E. Shepherd gives an account of the varied shapes of the lapillus or otolith found in the *recessus utriculi* portion of the ear-labyrinth of Teleostean fishes. He has previously dealt with the "asteriscus" and many "sagittæ." Twenty-four types are figured. In sturgeon the place of the lapillus is taken by otoconia

* Journ. Linn. Soc. (Zool.) xxxii. (1915) pp. 295–306 (2 pls. and 1 fig.).
† Glasgow Naturalist, vii. (1915) pp. 43–6 (3 figs.).
‡ Zoologist, xix. (1915) pp. 257–62 (1 pl.).

(ear-dust) consisting of separate crystals of carbonate of lime. In a previous paper * the author dealt with the sacculus and its otoliths in a variety of types.

**Blood Vessels of Rabbit's Mammary Gland.**†—H. M. Wahl finds that the blood supply of the mammary gland during development and rest appears in the main to be secondary to the blood supply of the skin and the subcutaneous muscles. During functional activity, however, it becomes more independent, the blood supply of the alveoli being connected with the vessels of the ducts, and to a large extent, at least, independent of that of the stroma. The author points out that the irregularity in the retrograde metamorphosis of the gland and the changes in the blood supply are suggestive in relation to cancer-formation.

## INVERTEBRATA.

### Mollusca.

#### γ. Gastropoda.

**Structure of Burmese Slug.**‡—Ekendranath Ghosh describes in *Atopos* (*Parapodangia*) *gravelyi* sp. n. the body-wall, the pallial complex, the digestive system, the reproductive system, the nervous system, the eyes and ommatophore, and the pedal gland.

### Arthropoda.

#### a. Insecta.

**Inheritance in Euschistus.**§—Katharine Foot and E. C. Strobell have made experiments in crossing two species of Hemiptera—*Euschistus variolarius* and *E. servus*. The first of these has an exclusively male character which is not present in *E. servus*, namely, a distinct black spot on the male genital segment. It seems that the facts in regard to the inheritance of this black spot are out of harmony with the assumption that a factor for this character is carried and distributed by definite chromosomes. Whatever determines the genital spot in these hybrids, it cannot be an indivisible unit-factor. The authors have not been able to harmonize their results either with the Mendelian or with the blend type of inheritance. Castle's assumption of the varying potency of unit-factors may perhaps help.

**Inheritance in Hemiptera.**‖—Katharine Foot and E. C. Strobell have followed up their previous study of crosses between *Euschistus variolarius* and *E. servus*. Dr. Eltringham, of Oxford, has discovered that there is a marked difference in the length of the intromittent organ in the two species, and this has afforded a valuable control for

* Zoologist, xix. (1915) pp. 25–34 (6 figs.).
† Amer. Journ. Anat., xviii. (1915) pp. 515–24 (6 figs.).
‡ Records Indian Museum, xi. (1915) pp. 153–61 (4 pls.).
§ Journ. Linn. Soc. (Zool.) xxxii. (1914) pp. 337–73 (7 pls. and 2 figs.).
‖ Journ. Linn. Soc. (Zool.) xxxii. (1915) pp. 457–93 (7 pls.).

the results obtained in regard to the inheritance of the genital spot which marks *E. variolarius*. The study of this second exclusively male character supports in every detail the conclusions of the previous investigation. The results are out of harmony with the chromosome hypothesis of sex-determination and with the recent hypotheses of chromosome-distribution of unit-factors.

**Histolysis during Regeneration of Appendages in Certain Orthoptera.***—E. Bordage calls attention to a process of histolysis he has observed in studying the regeneration of the appendages of certain Orthoptera. Phagocytosis plays only a subordinate part in the disappearance of the old muscles; it is chiefly brought about by a special process of fatty degeneration giving rise to adipose flocculi and strands similar to those of normal adipose tissue. Sometimes the adipose tissue arising from the transformation of muscular tissue takes very irregular contours, at other times it takes the form of a network with very large meshes. All stages of transition between these forms have been observed, especially in Mantids. Since this process of histolysis and histogenesis sets in only during a moult, when the animal is motionless, and is not only not feeding, but is drawing upon its normal adipose tissue, the author is led to conclude that this special tissue is of purely internal origin, and is the result of a histolysis of the old tissue, especially the muscle. The nuclei of the adipose tissue arising in this way are the nuclei of the old tissue, modified in form and increased in volume. The transformation is probably due to an enzyme, apparently contained in the pre-existing or primary adipose tissue, for it is observed that transformation begins at the points where the muscles that are to disappear are in contact with the primary adipose tissue. The secondary tissue has a brief life, and soon gives place to the new muscle of the regenerated appendages. Whether phagocytosis aids in its disappearance has not yet been established.

**New Lice.**†—Bruce F. Cummings describes two new species, *Polyplax brachyrrhynchus* and *P. oxyrrhynchus*, of which large numbers, in different stages, were collected in Egypt from *Acomys cahirinus*, one of the Muridæ. A third form, *P. spinulosa*, is also discussed for comparison. An examination of the immature forms in these three species shows that the metamorphosis includes at least three distinct stages, although there may be more than two moults. The differences between Stages II and III are slight. In the first stage the louse is very soft and delicate, but even thus early the mouth-parts, thorax and legs are well chitinized. On the abdomen segmentation is absent except at the end, and sclerites are absent in all three stages, although in *P. oxyrrhynchus* and *P. spinulosa* minute pleurites appear in Stage II, and in Stage III of *P. brachyrrhynchus* also there are present weak pleurites of indefinite outline. The spiracles are large. In the last stage the head and thorax closely resemble the adult.

In all three stages the chætotaxy of the head and thorax is almost

* Comptes Rendus, clxi. (1915) pp. 155–9 (1 fig.).
† Proc. Zool. Soc., 1915, pp. 245–72 (16 figs.).

identical with that of the imago. The abdominal chætotaxy and the abdomen itself, however, undergo a very considerable metamorphosis at the last ecdysis into the imago. The metamorphosis of all three shows that there is a tendency for the hairs to develop from behind forwards, inasmuch as the terminal pleura develop hairs while the rest are still bare, and in *P. oxyrrhynchus* and *P. spinulosa* the sterna are at first also bare except in the last segment. There are always two hairs on each tergum and sternum, if hairs are present at all. Some of these early stages may represent stages in the phylogeny of the group, and in this connexion it is suggestive to recall that the Anopluran genus *Linognathus* is characterized by the large size of its spiracles and the absence of abdominal plates, just as *Polyplax* is characterized by the small size of the spiracles and the presence of the plates, so that in future it may be convenient to speak of the larva of *Polyplax* as the "Linognathus larva."

**Respiratory System of Mallophaga.***—Launcelot Harrison gives an account of the tracheal system of *Myrsidea cucullaris*, and takes a comparative survey of what obtains in other types of Mallophaga. The tracheal system of Mallophaga is disposed in two main trunks, with stigmatic, dorsal, and ventral branches, with four narrow commissures (neural commissures) in connexion with the main nerve masses, and with, in primitive forms, a posterior abdominal commissure. The stigmata are typically fourteen in number: one pair prothoracic, and six pairs abdominal, usually dorsal, typically on segments 3 to 8. At least two types of occluding apparatus are present. In the structure and relations of the respiratory system the Mallophaga agree very closely with the Anoplura, and also, in a more general way, with the wingless Copeognatha. As the respiratory system is very uniform, such divergences as do occur have considerable taxonomic interest.

**Mallophaga from Apteryx and their Significance.**†—Launcelot Harrison has found on skins of *Apteryx* (five species) at least three species of Mallophaga, which he refers to the genus *Rallicola* Johnston and Harrison. This genus includes Philopteridæ of small to moderate size; of a general form between *Philopterus* and *Degeeriella*, but nearer the latter; without distinct clypeal suture; with slight to well-marked sexual dimorphism of the antennæ; with a definite indication of two distinct articles in the tarsus; with the transverse bands of the abdomen continuous, or divided only by a narrow median line. But the best characters are found in the male genitalia, which are very distinctive, and in the genital plate and ventral pleural margins of the eighth segment of the female, which have a very distinctive chætotaxy. Harrison divides the genus into three sub-genera—*Rallicola* s. str., confined to Rallidæ; *Parricola*, found on Parridæ; and *Aptericola*, on Apterygidæ.

The author presents the following argument:—*Aptericola* is a normal parasite of *Apteryx*; *Aptericola* is certainly, at most, a sub-genus within the genus *Rallicola*: *Rallicola* is a universal parasite of rails, and of

* Parasitology, viii. (1915) pp. 101–27 (21 figs.).
† Parasitology, viii. (1915) pp. 88–100 (6 figs.).

nothing but rails, except for the Parridæ and Apterygidæ; *Apterivola* possibly indicates the type of Ischnoceran parasite that existed upon the Dinornithidæ; the Mallophaga of the remaining Ratitæ have nothing in common with those of *Apteryx*. The inference drawn is that *Apteryx* (possibly along with *Dinornis*) must be regarded as more closely akin to the Ralli than to any other living birds. Subsidiary deductions are that the Parridæ are ralline rather than limicoline, and that the Ralli are probably deserving of ordinal rank. The probability of affinity between *Apteryx* and Ralli has been hinted at by Fürbringer and argued for by Gadow, in both cases on morphological grounds.

**Mouth-Parts and Suction in Schizoneura lanigera.***—J. Davidson deals with the mouth-parts and associated structures in this Aphis. He gives a clear account of the way in which the plant juices are conveyed into the pharynx and then passed through the œsophagus into the stomach, and of the way in which the secretion from the salivary glands is forced by the salivary pump into the tissues of the host plant. It may be, considering the extreme minuteness of the suction canal, that the ascent of the cell-sap along this canal is largely due to capillarity, and that the addition of the saliva causes the surface-tension of the sap to be lowered, thus facilitating its ascent up the suction-canal.

**Leaf-hoppers of Maine.**†—Herbert Osborn gives an account of the Jassoidea of Maine, leaf-hoppers of minute size, that affect cereal and forage crops, fruit and garden crops, and forest trees. They usually rest with the legs drawn up well to the front end of the body, and in position for immediate jumping. When disturbed they take long leaps, which may carry them for several feet or enable them to take wing. Those frequenting grasses rise in a swarm as one passes along. The leaf-hoppers proper belong to the families Tettigoniellidæ, Jassidæ, Bythoscopidæ, and Typhlocybidæ, which are dealt with in turn. They are to be distinguished from the frog-hoppers, Cercopidæ, by the structure of the hind tibiæ, these being slender, prismatic in section, with two series of small spines along the border, while in Cercopidæ there are two or three spines along the tibia, but a wide circlet or crown of spines at the tip.

**Remarkable New Lamellicorn.**‡—Gilbert J. Arrow describes the male of *Xenaclopus borneensis* g. et sp. n., a new Lamellicorn from Sarawak. It belongs to the small group of Aclopinæ, hitherto known only from the southern part of South America and the northern part of Australia—two widely separated regions which have remarkable resemblances in their fauna. The small beetle now described differs little from *Phænognatha* and *Aclopus* in the essential features of the group (the peculiar development of the mandibles and labrum, the reduction of the maxillæ and labium, and of the number of joints in the antenna); it differs entirely as regards other characters common to all the hitherto

* Journ. Linn. Soc., xxxii. (1914) pp. 307–30 (2 pls. and 2 figs.).
† Maine Agric. Exp. Station, Bull. No. 238 (1915) pp. 81–159 (35 figs.).
‡ Ann. Nat. Hist., xvi. (1915) pp. 317–19.

known species (the greatly reduced abdomen, long metasternum, and consequent far-back position of the hind legs, and the extreme slenderness of the tarsi). It is also peculiar in the great size of the club of the antenna, a feature, of course, distinctive of the males, and also in a still more interesting peculiarity, in all probability peculiar to that sex, namely, the cleft inner claw of the front foot. The absence of the female is another significant point of agreement with *Phænognatha* and *Aclopus*, of which only a single female specimen has yet been recorded. It is probable that in in all the genera the females are sluggish, and differ from the males in habit.

**Study of Silver-Fish.***—J. W. Cornwall has made a study of a silver-fish insect, supposed to be *Lepisma saccharina*, which has done considerable damage to books, papers, and pictures in the Pasteur Institute of Southern India. The female insect deposits six to ten eggs at a time in crevices. The eggs are glistening white, 1·5 mm. by 1 mm., sometimes asymmetrical. Hatching occurs in forty-five to sixty days at laboratory temperature (18° to 20° C.), and the young insect resembles the adult in essential features. The first ecdysis occurs soon after hatching, and is followed by several others. Maturity is reached in about two years.

The insects are lucifugous. Their progression is usually a rapid run with frequent sudden pauses. There seems to be a slight preponderance of females. The antennæ and setæ are important as sensory structures.

The creatures can live for 138 days without food; the mean in the starving experiments was eighty-eight days. They eat paper, cloth and the like. How they obtain proteid food in their usual surroundings is not obvious. They devour their dead neighbours. They do not tolerate moist cold or dry heat. Nothing but concentrated vapours and gases will destroy adults. The external and internal structure is described with care, and an account is given of two distinct Gregarines found parasitic in the gut.

### δ Arachnida.

**Antillean Spiders.**†—Frank E. Lutz has considered the distribution of the West Indian spiders, and has come to the conclusion that there has been considerable movement between the individual islands and also between the mainland and the islands, especially at the two ends of the island chain, even in recent times when the islands were separate from each other and from the mainland. It is therefore unnecessary to suppose that land connexions ever existed. Ancient forms have had a longer time to reach the islands than the more recent ones; they were adapted to a tropical environment, and the insular character of the area has protected them, hence a large part of the fauna consists of relicts, as is shown by the relationships with South Africa, Madagascar, Ceylon, Australia, and the Philippines. Recent forms are now mingling with and replacing the older forms.

* Indian Journ. Med. Research, iii. (1915) pp. 116–31 (6 pls.)
† Ann. New York Acad. Sci., xxvi. (1915) pp. 71–148 (8 figs.).

The means of over-sea dispersal are discussed. Young spiders of nearly, if not quite, all families are more or less given to "ballooning." Ocean drift may also aid, and many spiders are carried as stowaways on ships.

### ε. Crustacea.

**Regeneration of Limbs in Crustaceans.***— J. H. Paul gives an account of a series of observations and experiments on the regeneration of the legs of decapod Crustacea from the pre-formed breaking plane. *Homarus vulgaris*, *Eupagurus bernhardus*, and *Carcinas mænas* were taken as species typifying the process. All these form limb-buds or papillæ in the process of limb regeneration. These papillæ are covered with a chitinous envelope, and their outer form and size are adaptations to the requirements of the animal. The papilla has very complete sensory innervation, and this must provide for its protection by its possessor. As it has no calcareous outer coating it is able to increase in size, unlike the animal as a whole. The papilla of the lobster is straight, that of the hermit-crab curved, while the shore-crab has a papilla which may be folded on itself three times. Valvular action of the diaphragm at the breaking plane plays a greater part in the stopping of hæmorrhage after self-amputation than clotting does; and the dilatation of small vessels which pass beneath the epidermis detaches a layer of cells. This layer of epidermis proliferates from its free edges to form the new limb. A new diaphragm is the first structure laid down, and differentiation takes place from the base outward. Muscle arises at the growing tip from cells proliferated from the old epidermis (an ectodermal structure), and the nerve grows outwards from the torn end by cell proliferation. Muscle-fibres are anatomically complete immediately before moulting. The fibrillæ are cross-striated and enclosed in a sarcolemma, but full functional activity does not come till several days after moulting; it begins with slow, rhythmic movements. Sarcoplasm seems to be less abundant than in the normal fibre. When moulting occurs, the papilla is at once expanded to several times its previous size by valvular action, and the epidermis, previously composed of several layers of cells, now thins to a single layer, as is seen in the normal limb.

Some new points on autotomy among the decapod Crustacea are set forth in another paper by the same investigator.† He finds that autotomy of the walking-legs in the lobster and its allies is not a simple tearing at the third joint, as has often been stated, but is the result of a pluri-segmental reflex, which, among other things, causes great weakening of the limb at the central end of the third podomere along a groove running partly round the limb at this point. The weakening is due to a muscle—described and figured—inserted by a small tendon into the ventral edge of the third segment. In the lobster, autotomy of the walking-legs occurs about four seconds after nocuous stimulation. In the Brachyura there is a latent period of only a fraction of a second.

* Proc. Roy. Soc. Edin., xxxv. (1915) pp. 78–94 (4 pls.).
† Rep. Dove Mar. Lab., iv. (1915) pp. 44–52.

In the lobster, a walking-leg must be held in order that autotomy may be effected. This points to the probability that, in the lobster and its allies, evasion of an enemy has been the most important factor in the production of autotomy. Among crabs arrest of hæmorrhage must be regarded as the chief result of autotomy. A new description of the mechanism and nature of autotomy in the Macrura and Brachyura is given.

**Fresh-water Crabs of Ceylon.***—Jean Roux has made a revision of the fresh-water crabs of Ceylon, which, like those of peninsular India, all belong to the genus *Paratelphusa*. Six species are recognized, and *Barytelphusa*, *Oziotelphusa*, and *Liotelphusa* as sub-genera.

**Sub-antarctic Isopods.†**—Charles Chilton discusses the genus *Deto* and six species. One of the most striking features is the great sexual dimorphism exhibited apparently by all the species, and the varied forms that this takes. Thus in *D. bucculenta*, the male differs from the female in the possession of extraordinary balloon-like expansions of the first segment of the peræon; in *D. aucklandiæ*, in the longer spines arising from the segments of the peræon; and so on. All the species live on the sea-shore and are branchial breathers. The nearest affinities of the genus are probably with *Scyphax* and *Scyphoniscus*. As regards geographical distribution, they add a good example to the cases already known of closely allied forms being found on widely separated shores in sub-antarctic regions.

**Stomatopod Crustacea from Philippines.‡**—Stanley Kemp reports on a collection of Philippine Stomatopoda, which includes some interesting species, such as *Lysiosquilla vicina* Nobili, which, like its near relative in California, seems to inhabit burrows made by *Balanoglossus*, and *L. multifasciata* Wood-Mason, represented by nine specimens which illustrate the manner in which the characteristic pigmentation is developed. The author describes *Gonodactylus proximus* sp. n., and contributes a useful discussion of allied species.

**Genus Lernæodiscus.§**—Geoffrey W. Smith has studied what he previously called *Triangulus munidæ*, and finds that it should be ranked in the genus *Lernæodiscus* F. Müller. The genus *Triangulus* is withdrawn, and Kollmann's correction of the author's previous interpretation of the orientation of the parasite is accepted. The genus *Lernæodiscus* is thus defined:—External body of the adult yellow. Roots yellow, widely distributed and ramifying, without lagenæ. Mantle highly muscular, and thrown into lappets or folds to a greater or less extent. Mantle-opening situated either in the middle line, or more usually deflected to the right side, relatively to the host. Mesentery broad, pierced by the peduncle, which separates two hinges; the morphologically right hinge being applied to the thoracic surface, the left

* Rev. Suisse Zool. xxiii. (1915) pp. 361–84 (2 figs.).
† Journ. Linn. Soc. (Zool.) xxxii. (1915) pp. 435–56 (2 pls.).
‡ Philippine Journ. Sci., x. (1915) pp. 169–87 (1 pl.).
§ Journ. Linn. Soc. (Zool.) xxxii. (1915) pp. 429–34 (1 pl.).

hinge to the abdominal surface, of the host. The long axis of the parasite has undergone a peculiar rotation, which has resulted in bringing the nerve-ganglion and mantle-opening on to the right hinge of the mesentery. The colleterial glands (oviducts) are paired and convoluted. The genital openings are asymmetrically distributed owing to the rotation of the mesentery. The nauplius has somewhat elongated and curved frontal horns. The members of the genus are parasitic on symmetrical Decapoda Anomura. The following species are recognized:—*L. porcellanæ* F. Müller on *Porcellana* sp., *L. galatheæ* Smith on *Galathea dispersa* and *G. intermedia*, *L. strigosæ* on *G. strigosa*, and *L. munidæ* on *Munida bamffica*; but the author indicates the difficulty of finding criteria of a good species in animals which reproduce by a continuous round of self-fertilization, and offer no morphological feature of outstanding importance in which they differ.

**New Parasitic Copepod.***—M. Caullery and F. Mesnil describe *Xenocœloma brumpti* n. g. et sp., a remarkable Copepod found at Saint-Martin on *Polycirrus arenivorus* Caullery, an Annelid inhabiting the fine sand uncovered at low tide. It resembles *Sarcopsis alleni*, which Brumpt found on *P. aurantiacus* at Plymouth. The animal is reduced to a mass of tissue imbedded between the ectoderm and cœlomic epithelium of the Annelid. The outer wall of the parasite is replaced by that of the host: the cavity within the parasite is due to a hernia of the cœlom of the Annelid; no trace was seen of gut or nervous system; the gonads are hermaphrodite (a unique occurrence in Copepods); they are imbedded in adipose connective tissue; there is a large seminal vesicle. It seems that Brumpt's *Sarcopsis alleni* should be removed from Levinsen's genus *Sarcopsis* and ranked in this new genus *Xenocœloma*, which is certainly one of the most remarkable of parasitic Copepods.

**Monograph on Phyllopoda conchostraca.**†—E. Daday de Dees has completed his account of Conchostracous Phyllopods, dealing in the present instalment with numerous species of the genera *Eocyzicus* and *Cyzicus*.

**Androgynous Daphnids.**‡—R. de la Vaulx found a peculiar female form in a degenerating culture of *Daphnia atkinsoni*, which had not produced males or ephippia for six months. The form in question was in its general features typically female, but it had on the right side a male antenna. The rostrum was markedly asymmetrical, and the post-abdomen presented features of both sexes. Testes were not seen; the ovaries were equally developed on the two sides; the animal produced in its first brood twenty-five normal females. Another androgynous form had a slightly asymmetrical rostrum and a very short male antenna on the right side. The author suggests that the androgynous condition is associated with a reduction of reproductivity in conditions of malnutrition. Influences which would normally result

* Comptes Rendus, clxi. (1915) p. 709–12 (1 fig.).
† Ann. Sci. Nat. (Zool.) xx. (1915) pp. 193–330 (40 figs.).
‡ Bull. Soc. Zool. France, xl. (1915) pp. 102–4.

in so many males and so many females are concentrated on a single offspring which is, so to speak, pulled in two directions.

**Note on Daphnia atkinsoni.***—R. de la Vaulx discusses this species first described by Baird in 1879 from Jerusalem, and afterwards reported from Austria, Sweden, Russia, Spain, Greenland, and England. The author records its occurrence in France. Gurney has noted its abrupt appearance and disappearance in a marsh in Norfolk. The antennule of the female is very characteristic. It is sub-cylindrical and of large size: it bears terminally a number of relatively short sensitive rodlets; it has at its base externally a sensitive transparent seta rising from a clear disk. In the moult the carapace of the valves, instead of separating definitely from the cephalic part of the cuticle, is prolonged upwards in a heart-shaped portion. This piece is seen at the top of the ephippium and gives it a characteristic appearance. The resting eggs are disposed obliquely in unequal sub-triangular compartments.

**Cirripedia of Chilka Lake.**†—Nelson Annandale reports that two species, *Dichelaspis cor* Aurivillius and *Balanus amphitrite* Darwin, occur abundantly in the outer channel of the lake, where they probably breed. Larvæ of *B. amphitrite* almost certainly enter annually from the sea. In the main area of the lake a few specimens of *B. amphitrite* were noticed on rocks and boats. This species grows very rapidly and has great vitality. They often attach themselves to prawn-traps which lie exposed on the shore during the heat of the day. The other form, *Dichelaspis cor*, habitually occurs in the gill-chamber of a crab, *Scylla serrata*.

## Annulata.

**Oligochæta of Chilka Lake.**‡—J. Stephenson notes that the Oligochæta of brackish water are few, and do not form an independent ethological group. They seem to be forms belonging to the fresh-water or littoral groups, which possess the power of resisting a certain amount of admixture of salt or fresh water respectively. He describes from Chilka Lake *Enchytræus barkudensis* sp. n., *Pontodrilus bermudensis* Bedd. forma *ephippiger* (Rosa), and *Criodrilus lacuum* Hoffmstr., a well-known European form. Neither fresh-water nor littoral Oligochæta throw much light on zoogeography, for birds readily distribute the former (or their cocoons), and currents distribute the cocoons of the latter. Thus, *Nais paraguayensis* discovered in Paraguay has been found in Lahore, and *Enchytræus albidus* is found from Nova Zembla to Kerguelen Islands.

**Minute Structure of Tubifex.**§—Gertrude C. Dixon gives a full account of the minute structure of *Tubifex rivulorum*, which abounds in the mud of estuaries, often forming bright red masses. It is often

* Bull. Soc. Zool France, xl. (1915) pp. 100–1.
† Mem. Indian Mus., v. (1915) pp. 137–8.
‡ Mem. Indian Mus., v. (1915) pp. 141–6 (1 pl.).
§ Liverpool Mar. Biol. Committee Memoirs, xxiii. (1915) pp. 1–100 (7 pls.).

accompanied by *Limnodrilus udekemianus*, which has a striped appearance posteriorly, due to a band of yellow or orange pigment in each segment. Both worms hide themselves when the vessel in which they are kept is jarred, but only *Tubifex* responds in this way to a bright beam of light.

The red colour of *Tubifex* is due to the blood shining through. The setæ are capilliform, uncinate, and pectinate. Lankester's webbed setæ were not found. The body-wall has the usual layers—cuticle, epidermis, circular muscles, longitudinal muscles, and peritoneal epithelium. The clitellar gland-cells are described.

The cœlomic fluid contains spherical and amœboid corpuscles. The chloragogen cells of the gut have large nuclei, missed by some observers. These cells seem to become very inert in the adult; their function, if any, is probably excretory. The blood is a red non-corpusculated fluid. The vessels are carefully described, and the nervous and excretory systems.

The animal is hermaphrodite and fully mature from October to December. The first cocoons are laid about the beginning of November. A full description is given of the intricate reproductive system, and of the oogenesis and spermatogenesis. There are two kinds of spermatozoa. The spermatophores are visible to the naked eye, and when first liberated from the spermatheca appear as small, fine, white, glistening bodies, the largest being about 1–2 mm. in length. They have a complicated structure, largely due to the shape of the spermathecal duct and its aperture. The cocoons are made of a fibrous substance secreted by the clitellum; they may contain one egg or up to fourteen eggs. To *Tubifex* there are often attached groups of Vorticellids and clusters of fungus filaments. A primitive cestode, *Caryophyllæus*, occurs in the cœlom in the summer months, and there are several other parasites.

**Earthworms from Dutch New Guinea.***—L. Cognetti de Martiis describes *Pheretima maxima* sp. n., a giant form, 450 mm. in length, with a diameter of about 20 mm. and 108 segments. The setæ are in continuous rings, about 200 on segments vi. to x., and about 180 on segments xvii. to xxvi. Another form, *P. utakwana* sp. n., was found at an elevation of 10,000 feet.

**New Earthworm from Congo.**†—H. A. Baylis gives an account of the structure of *Dichogaster jaculatrix* sp. n. from the Ituri forest region. It is brightly coloured, 18 to 34 cm. in length, and when irritated or squeezed squirts jets of fluid from its dorsal pores. The spermathecæ have one to three small sessile diverticula visible externally, and usually contain spermatophores of characteristic forms with a capsule and trumpet-shaped tube. A detailed description is given of the spermatheca and the spermatophore. The author remarks on the difficulty of understanding the advantage of enclosing the sperm in an elaborately formed case.

* Trans. Zool. Soc., 1915, pp. 493–6 (1 fig.).
† Ann. Mag. Nat. Hist., xvi. (1915) pp. 449–65 (7 figs.).

### Nematohelminthes.

**Eggs of Ascaris lumbricoides.***—Lawrence D. Wharton has made a study of atypical eggs of this common parasite. Healthy-looking females were placed singly in glass dishes containing Kronecker's solution. This consists of common salt, 6 grms.; caustic soda, 0·06 grm.; distilled water, 1000 c.cm. The solution was changed daily, and a record was kept of the kind of eggs laid by each individual.

Typical eggs of *A. lumbricoides* are more or less oval. They average about 70 micra in length and 50 micra in breadth. There is a very thin vitelline membrane, and outside that a thick transparent shell consisting of an inner layer of chitin, and an outer layer of some albuminous material. The chitinous inner shell is made up of two parts—a thin, tough, very refractive layer, and a thicker, more brittle, outer layer which often shows very delicate striations. The egg does not entirely fill the shell, but forms a ball in the centre with a clear space at each end. The polar bodies are often seen in one of these clear spaces in a newly-laid egg.

On the outside of the chitinous shell is a thick layer of albuminous material, which is raised all over into small, round, blunt protuberances, producing a very characteristic mammillated appearance. It adheres very tightly to the chitinous part of the shell. When the eggs are just laid it is sometimes very soft and sticky, and this accounts for one of the commonest atypical forms found in the fæces. The mammillations are smoothed down and the layer becomes more compact.

Another common atypical form results from the entire absence of the outer albuminous layer, leaving the perfectly smooth chitinous surface. Such eggs are apt to be mistaken for those of some other worm. The author found that such atypical eggs, which were laid in the dishes, developed normally. The absence of the albumen from the surface must be due to some physiological condition which prevents the formation and deposition of the required substance by the uterine glands.

Unfertilized ova were also found. They are readily distinguished by the fact that the protoplasm of the egg is not surrounded by a vitelline membrane, and completely fills the shell. The protoplasm is more vacuolated than in the fertilized eggs. The shell may present any of the conditions found in the fertilized eggs. Moreover, some were laid in the dishes without any shell at all. Eggs in this condition would be destroyed in the fæces.

**Scottish Hairworms.**†—James Ritchie gives an account of the occurrence, habits, and characteristics of the Scottish Gordiidæ, with a key for the discrimination of the (five) species recorded from Britain. They occur in ponds, ditches and streams, less frequently among damp vegetation; they are well known to be marked by their elongated slender shape, tough cuticle, and deep brown colour; they sometimes occur in groups in an apparently inextricable knot.

* Philippine Journ. Sci., x. (1915) pp. 110–15.
† Scottish Naturalist, 1915, pp. 111–5, 136–42, 255–62 (1 pl.).

The eggs are fertilized within the female and are laid in long strings on water-weeds from April to August. A larva emerges, with a proboscis armed with bristles and hooks and a boring apparatus; it swims or crawls until it is able to penetrate into a larval insect (midge, alderfly, mayfly, water-beetle, etc.) or occasionally into some odd host, such as leech, fish or frog. It rests through the winter within the larval insect, most frequently in the muscular tissue, and is found in spring in the adult. The infected adult insect falls a prey to a carnivorous beetle, and in this the juvenile stage of the hairworm is reached. The body elongates until it all but fills the abdomen of the beetle, whence, after a period of development which has lasted a year and a half, it issues, a free and almost mature individual. It seeks the nearest water and there finally reproduces. The adult fasts, for the alimentary tract degenerates. The œsophagus is blocked by a solid mass of cells, and the mouth is closed by a plug of cuticle. An interesting note is made on the hairworm's head, which is paler than the rest of the body. Great use of it is made in locomotion, during which it is closely apposed to the stems of water-weeds and the like. Experiments made with *Parachordodes violaceus* whirled in a glass vessel showed that the head is pressed closely and at right-angles against the surface of the glass. The tip, especially the pale central portion, is pressed flat against the surface. It is possible that there may be an adhesive secretion, and an inquiry into this is in progress.

The diagnostic features of special value relate to the hinder end, which is forked in the males, and shows minute bristles or thickenings in varied patterns. As important are the markings on the cuticle, which are of three grades: an exceedingly fine diagonal meshwork, resembling on a delicate scale the "stipple" of a half-tone process block; a series of larger patterns of varying design—circles, areoles, meshes, etc.; and distinct protuberances or papillæ, sometimes with associated hair-like growths. The author describes the faceted hairworm, *Parachordodes violaceus* Baird, or *Gordius violaceus*: the large-spot hairworm, *Parachordodes tolosanus* Dujardin, or *Gordius tolosanus*; the lined hairworm, *Parachordodes pleskei* Camerano from Shetland, which is new not only to Britain but to Europe: and the mottled hairworm, *Gordius villoti* Rosa, new to Great Britain, recently recorded by Camerano from Ireland.

### Platyhelminthes.

**New Tapeworm from a Parakeet.***—F. J. Meggitt found in dissecting a Brazilian parakeet (*Brotogerys tirica*) several large tapeworms of the genus *Cotugnia*. They occurred in the duodenum, almost filling it. A new species, *C. brotogerys*, has to be established. The genus *Cotugnia* was created by Diamare for those avian Cestodes which have a double set of male and female reproductive organs in each proglottis, and a rostellum armed with T-shaped hooks. The suckers are oval, unarmed, imbricate; there is no neck; the segments are trapezoidal and imbricate; the genital pore is situated at the anterior third of the

* Parasitology, viii. (1915) pp. 42–55 (2 pls. and 4 figs.).

lateral margin; three longitudinal muscle layers alternate with three transverse layers. The testes are numerous, in a double row, occupying the centre of the proglottis, and extending laterally beyond the excretory canals. The yolk-gland is compact and posterior to the ovary; the receptaculum is spherical; the ovary is strongly lobed; there is no persistent uterus; the eggs have three membranes; they are enclosed in parenchymatous capsules, each containing several eggs. The spermatogenesis is described.

**Notes on Parasitic Worms found in Fishes.***—Edwin Linton has taken a wide survey, and finds no evidence of any marked seasonal periodicity in the occurrence of helminth parasites in fishes. Incidentally he refers to some other points. Nematodes, occasionally seen in the flesh of fishes, are likely to be destroyed in cooking, and are not likely in any case to find a suitable host in man. Cysts of a Cestode, *Otobothrium crenacolle*, are not infrequent in the flesh of the butter-fish, *Poronotus triacanthus*, and the adults are found in the spiral valve of the hammerhead shark and related forms.

**Larval Trematodes in Marine Molluscs.**†—Edwin Linton examined numerous different species of molluscs at Woods Hole, but found larval Trematodes only in two cases. In *Ilyanassa obsoleta* and in *Pecten irradians* there were sporocysts and cercariæ, which are described. A few cysts were found in the edible mussel. The author notes that the redia stage is omitted from the larval stages of Trematode development which he has observed in the Invertebrates at Woods Hole, and he calls attention also to the abbreviation of life-history in the Distome, *Parorchis avitus*, from the herring gull, where miracidia, still within the ova in the uterus, contained each a single well-developed redia.

**Comparative Anatomy of Anoplocephalidæ.**‡—H. Douthitt gives the result of his investigations towards a comparative anatomical study of the Cestode family of the Anoplocephalidæ. The paper consists mainly of descriptions of individual genera and species, but certain general conclusions have been arrived at. The Cestodes of the subfamily Anoplocephalinæ are in some way dependent on rich soils for their existence, and they thrive best in wet lowlands. The evidence points to the conclusion that the intermediate hosts are insects confined to such regions: and since the hosts of the Anoplocephalidæ are almost exclusively herbivorous, it would seem probable that this host is a small insect feeding on plants. The primitive Anoplocephaline uterus was of the reticulate type, which in turn was derived from a median longitudinal tubular uterus by lateral outgrowths. The transverse tubular and diffuse uteri of this group have been derived from the reticular by simplification. In the early primitive Anoplocephalidæ the uterus crossed the excretory ducts ventrally; subsequently it became restricted to the median field, and later came to cross the excretory ducts dorsally. The position of the vaginal pore and vagina is one of the most stable

* Trans. Amer. Fisheries Soc., 1914, pp. 48–56.
† Biol. Bulletin, xxviii. (1915) pp. 198–209 (8 figs.).
‡ Illinois Biol. Monographs, i. (1915) pp. 5–96 (6 pls.).

anatomical characters of the Anoplocephalinæ, and should be admitted as one of the most important criteria of relationship. The primitive position of the vagina was posterior to the cirrus pouch. The more generalized representatives of the genus *Andrya* approach most nearly of all the known Anoplocephalidæ to the ancestral types of the family. Leaving out of consideration the aberrant *Triplotænia*, the genera *Moniezia* and *Schizotænia* constitute the highest types of the Anoplocephalinæ; the other sub-families of the family seem to have sprung from forms like these two genera. Cestodes exhibit a high degree of variability, and great caution is needed in coming to conclusions regarding structure and consequent relationships.

**Trematode from Protopterus.*** — H. A. Baylis describes a Trematode parasite from an African mud-fish (*Protopterus æthiopicus*). The type, which is believed to be new to science, and to which the name *Heterorchis crumenifer* (g. et sp. n.) has been given, is of interest both because little is known of the parasites of its host, and because of its structural peculiarities and probable systematic relationships. The form seems to approach most closely to the Trematodes of the family Lepodermatidæ. The points in which it is exceptional are, the unequal size of the testes, and the condition of the excretory system, which has a peculiar dorsal sac and wide aperture. The genera to which it is most closely allied are *Ochetosoma* Braun, *Renifer* Pratt, and *Lechriorchis* Stafford. These three genera are, with very few exceptions, parasitic in the mouth, lungs, œsophagus and stomach of snakes, apparently having a preference for situations more or less accessible to the outer air. There is, however, nothing to show that the new species, which lives in the intestine of its host, has any access to the air, and its occurrence in an air-breathing fish is probably a pure coincidence.

The species is fully described and figured, a generic diagnosis is given, the possibility of a relation between the function of the dorsal sac and the æstivation of the mud-fish is suggested, and the homologies of the different parts of the excretory system are discussed.

**Skin Parasite of Fishes.**† — Edwin Linton finds that certain Trematodes in the skin of the Cunner (*Ctenolabrus adspersus*) and some other fishes of the Woods Hole region are the young of an adult which lives in the intestine of the loon and other fish-eating birds. The identification of these encysted distomes with *Tocotrema lingua* (Creplin) dispenses with the need for Stafford's name (*Dermocystis ctenolabri*) for the encysted forms. The parasites from the loon are described and their essential agreement with those from the fishes is indicated.

**Sporocysts in an Annelid.**‡ — Edwin Linton obtained from the Serpulid worm, *Hydroides dianthus* Verrill, large numbers of actively contractile fusiform or otherwise shaped sporocysts. In each sporocyst there were cercariæ of different stages, very like forms found in the scallop, but moving in a different way. "Instead of a characteristic

* Ann. Mag. Nat. Hist., xvi. (1915) pp. 85–95 (3 figs.).
† Journ. Parasitology, i. (1915) pp. 128–34 (3 figs.).
‡ Biol. Bulletin, xxviii. (1915) pp. 115–8 (5 figs.).

pecking motion of the anterior end, the cercariæ from the Annelid, occasionally, after lying motionless for a time perform exceedingly rapid wriggling movements." The anterior end bears a short rectractile boring apparatus. What were interpreted to be striated muscle fibres were observed in the tails of the cercariæ.

### Incertæ Sedis.

**Variations in Sperifer mucronatus.***—C. C. Mook has studied five mutations of this fossil species, seeking by statistical methods to determine their relations to one another and the progress of evolution along the different lines. A diagram sums up the relationships. The tendency has been to reduce the shell index, to reduce the number of plications, to lose the groove and plication on fold and sinus, and to a certain extent to reduce the actual width of the shell.

**Early Stages of Cephalodiscus.**†—J. D. F. Gilchrist contributes some very interesting observations on the Cape species, *Cephalodiscus gilchristi*, with special reference to the larvæ. The normal habitat appears to be rocky ground in rather shallow water, below low-water mark. It is either attached to rock or to some substance growing on rock, but may become detached and carried on to muddy ground. It seems to be abundant on the south coast. It may grow from a small basis, or the basis may be a broad sheet of cœnœcial substance from which several main stems arise.

In the living state the zooids and buds have been observed on the general surface of the cœnœcium outside the tube, and sometimes at a distance from it. The buds in such cases act as anchors, being firmly adherent to the surface by their proboscides. In both bud and zooid a quantity of viscid mucus occurs between the proboscis and the cœnœcium.

There is no evidence that the buds ever develop into normal zooids, and they may be individuals specialized for adhesive purposes and cœnœcium-building. More than one zooid and its buds may occur in one tube in the cœnœcium in the Cape species. Buds and zooids are provided with cilia over the whole of their surface. Their stolons or stalks are also ciliated. The method of feeding is that particles are carried by means of these cilia to the arms, where a selection is made of the food-particles, which are returned to the mouth by the grooves in the arms. The zooids and buds are black in the living condition, but the colour dissolves out very quickly in preservation.

The eggs are enclosed in a capsule, which is adherent by one end to the wall of the tube. The embryo is ciliated and coloured at an early stage, the older embryos being folded on themselves. They rotate actively in the egg-capsule. The free larva is elongate, ovoid, and usually narrower posteriorly, where an indentation is usually seen. An apical sense-organ appears early in the embryo, and is present in the larva in the form of a white area surrounded by a dark ring of pigment-

* Ann. New York Acad. Sci., xxvi. (1915) pp. 175–214 (8 figs.).
† Ann. Mag. Nat. Hist., xvi. (1915) pp. 233–46 (1 pl.).

spots. The larva is uniformly ciliated, and progresses actively over the surface on which it occurs. It is not free-swimming, and rapidly sinks to the bottom when placed in the water. It secretes a viscid substance by means of which it adheres somewhat securely to the substratum. The ventral surface has a thickened foot-like area.

Sidney F. Harmer adds an appendix with particular reference to recent literature not available to Gilchrist. He does not accept the conclusion that "there is no evidence that the buds ever develop into normal zooids, and that they may be individuals specialized for adhesive purposes and cœnœcium-building." The occurrence of almost innumerable individuals in a single colony almost necessarily presupposes that the number of individuals increases by budding; while Gilchrist's observation that several zooids may occur in the individual cœnœcial tubes of *C.* (*Idiothecia*) *gilchristi* indicates, in all probability, that some of the buds have assumed an adult character.

A summary is given of the facts in regard to development which seem to have been securely established. The egg of *Cephalodiscus* is of considerable size—reaching a diameter of 680 $\mu$ in *Orthoecus solidus*—and it contains a large quantity of yolk. Segmentation is complete and leads to the formation of a gastrula-like stage, although the mode of origin of the inner layer has not been definitely established. The lumen of the archenteron is very small, in correlation with the large amount of yolk. The yolk is present in the cells of the inner and outer layers in the earlier stages of development; but it later disappears from the outer layer, persisting in large quantity in a central mass representing the wall of the archenteron, the cavity of which remains very small. The wall of the archenteron is continuous with the outer layer, in the later stages observed, near the posterior pole of the embryo. This region may be regarded as the blastopore, and it seems probable that it gives rise to the anus.

The free-swimming larvæ and the later embryos possess five body-cavities arranged like those of the adult—namely, a large anterior cavity and two pairs of clearly marked cœlomic sacs, representing the body-cavities of the collar and metasome respectively. These cavities are, perhaps, developed as enterocœles.

A large area of the ventral ectoderm is much thickened and is occupied with numerous gland-cells resembling those of the anterior or "ventral" wall of the adult proboscis or buccal shield, and probably gives rise to that part of the zooid. The anterior pole of the larva is provided with a mass of clear vacuolated cells, situated in the ectoderm. This organ is perhaps sensory. In *C. indicus* it has been shown by Schepotieff to bear a central tuft of long cilia and to be surrounded by a circlet of smaller cilia. With the exception of the cilia just indicated the larva is not known to carry definite rings of cilia, although part at least of its ectoderm is uniformly covered with short cilia. The posterior pole of the larva is generally provided with a definite ectodermic invagination of unknown nature, which has been called the "posterior pit." The deeper parts of the ectoderm of the larva already show signs of the development of a diffuse nerve-plexus. It appears improbable that there is any pelagic stage and the observations of Andersson seem to indicate that the larva becomes a zooid by direct metamorphosis.

## Rotatoria.

**Rotifera of Lake Geneva.***—G. Montet has added records of sixty Rotifers to the faunistic list for the region of Lake Geneva. This brings the total up to 207, and includes three new species—*Macrotrachela gracilis*, *Rotifer tridens*, and *Pleurotrocha minima*. Of the 128 species collected by the author, 92 were exclusively aquatic—either pelagic or littoral; 28 were obtained only from mosses; 8 frequent aquatic plants or terrestrial mosses. Particular attention has been paid to the marshes and the like in the region around the lake.

## Echinoderma.

**Aristotle's Lantern and the Calcareous Ring in Holothuroids.**†—E. Herouard maintains the homology of these two structures. The five inter-radial pieces of the ring correspond to the five alveoli of the lantern; the five radial pieces of the ring correspond to the rotulæ and radii of the lantern. In the development the splanchnopleure gives off a diverticulum in each inter-radial space, and these five diverticula, becoming separated off, form the five intra-alveolar sinuses of the lantern. It is probable that similar diverticula in Holothuroids remain in communication with the splanchnocœle. The inter-radial skeleton of lantern and ring arises in the cœlopleural connective tissue of the five diverticula, but is restricted in Holothuroids to the external surface. The radial skeleton in both types develops from the cœlopleure of the general cavity. The peripheral skeleton is of ectopleural origin. The author points out the importance of Spencer's concept of "architectonic unities," such as the five diverticula must be held to be.

**Oxidations in Egg of Sea-urchin.**‡—Jacques Loeb and Hardolph Wasteneys have followed up Warburg's discovery that NaOH raises the rate of oxidations in the fertilized eggs of the sea-urchin, though it does not enter the egg. The inference was that the oxidations raised by NaOH must be located at the surface of the egg. The experiments on *Arbacia* made by Loeb and Wasteneys suggest that a weak base accelerates oxidations both at the surface and beneath the surface layer, while the strong bases are confined in their action to the surface layer. The surface and the adjacent layers appear to be the seat of oxidations, comparatively little diffusing into the cell.

## Cœlentera.

**Cœlentera of Chilka Lake.**§—Nelson Annandale reports on sixteen species of Cœlentera from this lake, namely, six Actinozoa, one Scyphomedusa (*Acromitus rabanchatu* sp. n.), and nine Hydrozoa. The Actiniaria include species of the primitive genera *Edwardsia* and *Halianthus*, neither of which appears to have been previously recorded from the Indian Ocean. They also include two new genera *Phytocoetes*

* Rev. Suisse Zool., xxiii. (1915) pp. 251–360 (7 pls.).
† Bull. Soc. Zool. France, xl. (1915) pp. 117–23 (4 figs.).
‡ Journ. Biol. Chem., xxi. (1915) pp. 153–8 (1 fig.).
§ Mem. Indian Mus., v. (1915) pp. 67–114 (5 pls. and 10 figs).

(perhaps a permanent post-larval form of *Metridium schillerianum*) and *Pelocoetes*. Among the Gymnoblastea a new genus *Dicyclocoryne* is established in the family Corynidæ. Four of the Cœlentera of Chilka Lake are casual visitors from the sea, three are periodic immigrants from the Bay of Bengal, and nine are permanent inhabitants. Among the last is a Virgularian not yet named.

**Australian Hydroids.***—W. M. Bale completes his report on the Hydroids collected by the "Endeavour" from the Great Australian Bight and other localities. Altogether sixty-four species or varieties are represented in the collections, and of these twenty-two species and four varieties have been ranked as new. This last part of the report describes the following new forms:—*Sertularella tasmanica*, *S. undulata*, *S. pusilla*, *Nemertesia ciliata* var. *cruciata*, *Aglaophenia divaricata* var. *cystifera*, and *Cladocarpella multiseptata*. In two or three instances the new material has enabled the author to describe the gonangia of species, of which the gonosome was previously unknown.

**New Cornularid.**†—S. F. Light describes *Cornularia minuta* sp. n., a minute Cornularid found at the Philippines growing on colonies of *Siphonogorgia variabilis*, to which it is attached by creeping, anastomosing, threadlike stolons. The polyps are dirty white to light yellow, with a maximum length of 2·5 mm., without spicules. Each stolon has two or more endodermal canals in the homogeneous mesoglœa. The stolons are covered with a very thin, wrinkled, perisarc-like, horny envelope, an extension of which forms a cup-like covering for the basal portion of the polyps. Externally the species suggests *Cornularia*, but in many respects it is also like *Clavularia*. Perhaps it links the two. The ectoderm of the tentacles contains in many places large numbers of oval bodies, the nature of which, whether Zooxanthellæ, or Protozoa, or something else, remains obscure.

**New Species of Lithophytum.**‡—S. F. Light describes *Lithophytum philippinensis* sp. n. and *L. rigidum* sp. n., the first species of this genus to be reported from the Philippines. The first species differs from all others except *L. ramosum* and *L. stuhlmanni* in the absence of spicules from the polyps and from the cortex of the distal portion of the colony. The second species is not far off, but is short, bushy, and stiff.

## Protozoa.

**Foraminifera of Kerimba Archipelago.**§—E. Heron-Allen and Arthur Earland continue their account‖ of the Foraminifera collected by J. J. Simpson from this part of Portuguese East Africa. There is a striking similarity between the general facies of the gatherings and

* Biol. Results Fishing Exper. Australia, iii. (1915) p. 241–336 (2 pls.).

† Philippine Journ. Sci., x. (1915) pp. 203–13 (7 figs.).

‡ Philippine Journ. Sci., x. (1915) pp. 1–8 (2 pls. and 3 figs.).

§ Proc. Zool. Soc., 1915, pp. 295–8; and Trans. Zool. Soc., xx. (1915) pp. 543–794, (14 pls. and 3 figs.).

‖ See this Journal, 1915, pp. 153–4.

that described by the late F. W. Millett in reference to a collection from the Malay Archipelago. The authors found abundant representation of D'Orbigny's *Paronina flabelliformis*, which Brady re-discovered and described, and after ninety years they have re-discovered D'Orbigny's *Rotalia dubia*, whose position among Rhizopods is no longer doubtful.

The leading zoological feature of the Kerimba gatherings is perhaps the great abundance of the Miliolidæ. The authors make notes on 122 species in this family, seventy-seven in the genus *Miliolina*, of which six are new. A revision is given of the lituiform species of *Peneroplis*. The short stout spirilline forms must be included under *P. arietinus* Batsch, the long narrow forms must be *P. cylindraceus* Lamarck, and the specific name *lituus* must lapse altogether, its place being taken by Chapman's genus and species *Monalysidium polita*.

In regard to the previously described abnormal specimens of the genus *Iridia*, in which the arenaceous investment is limited to an encircling wall, the two faces of the shell being formed by transparent chitinous pellicles, a similar appearance is figured by Rhumbler in *Vanhoeffenella gaussii* from a depth of 400 metres in the Antarctic. Rhumbler suggested that the transparent pellicle might serve as a window by which the animal may obtain some benefit from the lost rays of sunlight penetrating to the depth indicated. It is not at present possible to decide whether *Vanhoeffenella gaussii* is identical with the abnormal form of *Iridia*, and Rhumbler does not seem to have known other forms of the organism. The window theory would not apply well in the case of forms living in the glare of tropical sunlight in the shallow waters of the Kerimba reef, and the authors think that the forms they described are simply abnormal forms which have grown between two large sand-grains and have subsequently become detached. The chitinous pellicle is the ordinary chitinous lining exposed.

The Kerimba material has furnished a fine series of double shells of *Discorbina*, which Heron-Allen regards as supporting his interpretation of "plastogamy" as really a process of budding. The peculiar dual nature of the terminal balloon-chamber, which Earland first noticed in *Cymbalopora bulloides* D'Orbigny is discussed at length, and its development is described.

Very remarkable is the discovery of specimens of *C. tabellæformis* filling little pits in mollusc shells. Each Foraminifer seems to have been able to enlarge its crypt to accommodate the growth of its shell, and also to excavate tunnels, exceeding in length many times its own diameter, in the host-shell. These are for the pseudopodia. It is curious that living matter which secretes lime should also dissolve it, and it is possible that a part is played by carbon dioxide given off by the symbiotic Algæ usually associated with this Foraminifer. The Kerimba material has yielded 470 species and varieties, of which 32 are new to science.

# BOTANY.

## GENERAL,

### Including the Anatomy and Physiology of Seed Plants.

### Cytology,

#### Including Cell-contents.

**Picro-nigrosin.***—O. F. Curtis and R. H. Colley indicate the great value of Picro-nigrosin as a combined fixative and stain for demonstrating the finer structure of small algæ, etc. It is prepared by saturating a saturated aqueous solution of picric acid with Gruebler's water-soluble nigrosin. There is no danger of overstaining or overfixing. The excess is removed by rinsing in water or diluted alcohol. The stain is insoluble in strong alcohol; and it keeps well in Venetian turpentine or balsam. It is an exceptionally transparent stain, and differentiates the nuclear structure in cells with dense cytoplasm.

### Structure and Development.

#### Vegetative.

**Morphology of Lemna Frond.**†—F. H. Blodgett publishes a paper in which an effort is made to show what structural units contribute to the formation of the frond of *Lemna*. This frond is a reduced structure especially adapted to vegetative propagation in water: it results from the action of two factors, viz. the film-tension of the water and the upward thrust due to buoyancy. The roots act as a check against free movement and tend to orient the plant when immersed by sudden shock. The frond consists of a terminal leaf; a bud enclosed by a bud-scale, the base of which is fused to the base of the leaf and to the stem; and an apical region giving rise to new fronds. The lack of space for vertical growth causes the outgrowth from the apical region to assume a horizontal series, the successive individuals overlapping each other in a confused manner.

**"Bars of Sanio" in Cycads.**‡—H. B. Sifton has studied the structure of the xylem of the vascular bundle found in the petiole of *Cycas revoluta*, and finds that the thickenings in the primary wall, known as the "bars of Sanio," and hitherto thought to be absent in the Cycads, are very distinctly marked. These "bars" are distinguished by two features, viz. the close adherence to the borders of the pits and

* Amer. Journ. Bot., ii. (1915) pp. 89–92.
† Bot. Gaz., lx. (1915) pp. 383–90 (1 pl. and 1 fig.).
‡ Bot. Gaz., lx. (1915) pp. 400–5 (1 pl.).

by never reaching across the tracheides. These two features have been regarded as specially characteristic of the "bars" found in the Araucarineæ, and have been used as an argument in favour of the Abietinean ancestry of the latter. Not only does the present discovery render this argument valueless, but a comparison of the "bars" in the different regions of the Abietineæ appears to favour a reverse relationship. The type of "bar" found in the Cycads and Araucarians is without doubt ancestral to that found in a more specialized form in the higher conifers, and still persists in the primitive parts, i.e. the cone-axis and root of the latter.

### Reproductive.

**Pollen-formation in Monocotyledons.***— L. Guignard contributes a second note upon the method of pollen-formation in Monocotyledons. The author has now examined three other genera belonging to the Iridaceæ, viz. *Gladiolus*, *Tigridia*, and *Crocus*, and finds that they agree with those previously examined in forming their pollen by simultaneous quadripartition. It appears, therefore, that this mode of pollen-formation is general throughout the Iridaceæ, and that both this group and that of the Orchidaceæ resemble the Dicotyledons rather than the Monocotyledons in this respect.

## CRYPTOGAMS.

### Pteridophyta.

(By A. Gepp, M.A. F.L.S.)

**Anatomy of Nephrolepis volubilis.**†— Birbal Sahni gives an account of the anatomy of *Nephrolepis volubilis*, with remarks on the biology and morphology of the genus. This fern is highly specialized. The primary stolons climb some 50 feet up forest trees, and enable lateral plants, borne on them at intervals, to reach heights far above the mother-plant which is rooted in the soil. Two to four shorter stolons, wiry and irregularly coiled, appear on each lateral plant, and seem to be contact-sensitive. They are climbing organs. The stolons possess a single axial polyarch exarch protostele. In the endodermis peculiar radial strut-like bodies were found. In the lateral plants the basal protostele becomes soon modified into a primitive form of dictyostele at the apex; the first leaf has a compound leaf-trace; there are no roots. The primary stolons of several species of *Nephrolepis* are probably positively hydrotropic. In *N. ramosa* and *N. altescandens*, two closely allied species without stolons but with scandent rhizomes, the internode has a dictyostele of the very simplest type. In *N. ramosa* the vascular structure at the base of the branch and leaf-traces is almost identical, and recalls the condition of the Hymenophyllaceæ. In *N. altescandens* the leaf-trace arises as two separate strands, in

* Comptes Rendus, clxi. (1915) pp. 623–5.
† New Phytologist, xiv. (1915) pp. 251–74 (1 pl. and figs.).

*N. ramosa* as a simple C-shaped strand. Sperlich's view as to the origin of epiphytism in the genus is well borne out by a study of *N. volubilis*. He regards the stolon as having been the initial stage in the gradual emancipation of the plant from the soil. Velenovsky's adoption of a new morphological category, the "Achsenträge" (shoot-bearer), to include the stolons of *Nephrolepis*, has no justification in view of the evident cauline nature of these organs. The primitive organization of the stolon is not indicative of primitiveness of the genus More probably it is an organ highly specialized for the conducting functions entrusted to it. Possibly because of the exceptionally favourable physiological conditions in which it is placed (connected by the stolon to the absorbing system of the mother-plant) the lateral plant of *N. cordifolia* (and perhaps of other species) in its ontogeny omits some of the earlier stages in stelar evolution which are shown by the sporeling.

**Fossil Osmundaceæ.***—R. Kidston and D. T. Gwynne-Vaughan, in the fifth part of their memoir on fossil Osmundaceæ, give descriptions and figures of the structure of *Osmundites spetsbergensis*, from Spitzbergen, of the type of *O. Carnieri*, from Paraguay, and of two fragments from Queensland.

**Anatomy of Hybrid Equisetum.**†—Ruth Holden gives an account of the anatomy of a hybrid *Equisetum*; and in summing up her results says:—(1) *Equisetum variegatum* var. *Jesupi* is probably a hybrid between *E. variegatum* and *E. hiemale*, for the following reasons: (*a*) It has some of the characters of the first, some of the second, and some intermediate; (*b*) a large number of its spores are always abortive. (2) Whether it represents the immediate offspring ($F_1$) of the cross, its relation to other varieties also intermediate between *E. variegatum* and *E. hiemale*, whether the cross is repeated for each individual, how far hybridization will explain the large number of transitional forms in the genus *Equisetum*, are all points to be cleared up by further investigation.

**Protocorm of Lycopodium.**‡—J. E. Holloway publishes a preliminary note on the protocorm of *Lycopodium laterale*. He finds that:—(1) In *L. laterale*, and occasionally in *L. cernuum*, the protocorm is capable of separate existence for a lengthy time, thus bridging over the period between the dependent embryo and the independent plant. The vascular strand of the stem and first root takes a course through its tissues. The rhizome of *L. laterale* may soon branch and give rise to more than one stem-axis. (2) In *L. laterale* there is a marked developmental distinction between the protocorm and its rhizomatous extension. (3) The manner of development of the protocormous rhizome suggests that its large size is an adaptation to carry the young plant over the dry season. (4) In *L. laterale* the protocorm is associated with the *cernuum* type of prothallus. Such a type of prothallus is regarded as primitive

* Trans. Roy. Soc. Edinburgh, l. (1915) pp. 469-80 (4 pls. and figs.).
† Amer. Journ. Bot., ii. (1915) pp. 225-38 (4 pls.).
‡ Trans. Proc. New Zealand Inst., xlvii. (1915) pp. 73-5.

for the genus. The fact that the protocormous species belong to two groups in the sub-genus *Rhopalostachya* suggests a certain degree of antiquity for the protocorm within the genus *Lycopodium*; and, if the *cernuum* type of prothallus be primitive, would suggest that *Rhopalostachya* comprises the more primitive Lycopodiaceæ, and that the genus as a whole should be regarded as a reduction series rather than as a series which has progressed from those which show the simpler type of sporophyte.

**Prothallium of Lycopodium.***—K. V. Edgerley gives the result of her investigation of the prothallia of three New Zealand species of *Lycopodium*:—1. Spores of *L. Billardieri* and *L. novæ-zelandicum* do not germinate readily. 2. Prothallia of *L. volubile* and *L. scariosum* resemble one another externally. Both are colourless and saprophytic, but that of *L. volubile* may come above the surface, and it is smaller. Prothallia of *L. Billardieri* and other epiphytic species resemble those of *L. phlegmaria*. 3. As to structure of prothallia, *L. volubile* and *L. scariosum* resemble *L. clavatum*, but *L. scariosum* has but one-sixth of its tissue infected with fungus. *L. scariosum* resembles both *L. clavatum* and *L. annotinum* in having a single row of cells elongated at right angles to the surface on the prothallium, and having the fungus intracellular. This layer is absent in *L. volubile*. In *L. Billardieri* there is a close resemblance to *L. phlegmaria*, but no pits were seen in the walls of the elongated central cells, though in the walls of the peripheral layer the pits were very conspicuous. 4. Starch was abundant in both *L. volubile* and *L. scariosum* in the parenchymatous storage layer; and in *L. scariosum* the walls of the cells below stained light-blue with iodine, as if the fungus filaments in the wall contain starch. 5. Fungus was present in all three species, *L. volubile*, *scariosum* and *Billardieri*. In the first the fungus does not enter the rhizoids, but pierces the wall of the basal cell of the rhizoid and so comes into contact with the humus: while in *L. scariosum* the hyphæ are found also in the cavities of the rhizoids. 6. As to reproductive organs—antheridia in all three species were of the usual Lycopodiaceous type, those in *L. volubile* projecting a little above the surface, while those in *L. scariosum* and *L. Billardieri* were completely sunk in the prothallium. The archegonial development is also normal, but for variation in number of the neck-canal cells—four to seven in *L. volubile*, six in *L. scariosum*, five in *L. Billardieri*. The paraphyses of *L. Billardieri* are composed of fewer cells than in *L. Selago* and *L. phlegmaria*, and are usually unbranched. 7. The embryology was not traced in detail; but the embryos of *L. volubile* and *L. scariosum* are undoubtedly of the *L. clavatum* type. There is a larger persistent foot and no sign of a protocorm. In *L. Billardieri* the foot is fairly large and persistent.

* Trans. Proc. New Zealand Inst., xlvii. (1915) pp. 94–111 (figs.).

## Bryophyta.

(By A. Gepp.)

**Sporogenesis of Sphagnum squarrosum.***—E. Melin describes the sporogenesis of *Sphagnum squarrosum* Pers., and adds remarks on the antheridium of *S. acutifolium*. The work is divided into four chapters:—1. The sporogenesis of *S. squarrosum*. 2. The chromatophores of *Sphagnum*. 3. Remarks on the antheridium of *S. acutifolium*. 4. The systematic position of *Sphagnum*. In the first chapter the nuclear division of *S. squarrosum* is minutely described. In the second the author discusses the behaviour of the chromatophores of the sporophyte. The cells of the young sporophyte contain, like the egg-cell, several chromatophores. In the young archespore, however, they do not appear to divide, but distribute themselves among the daughter-cells, so that in each archespore there is finally only one chromatophore. The sterile sporophyte-cells on the other hand have always several chromatophores. In the spore-mother-cells the number increases from one to four, and each of the four young spores receives one. This fact is considered by the author as one of great systematic importance. As regards the antheridium (chapter III.) the first divisions take place as Leitgeb describes. A two-edged apical cell is formed. The divergence of the cells is not however one-half, but much smaller. Each segment is, like the Muscineæ and the Jungermanniales, divided into three cells by two walls having a chord-like course, one outer and one inner. The androcyte mother-cells are elongate-ellipsoidal, as in mosses, and their spindles are orientated in their lengthwise direction. In the cytoplasm of the androcyte mother-cells there appear two bodies, highly stainable, of which there was no trace in the preceding mitoses. The author calls them "Blepharoplasten," since they are in his estimation identical with the cilia-forming bodies occurring in the androcytes.

As regards the systematic position of *Sphagnum*, the author is of the opinion that it is a true moss, and has been developed from a moss-like type. The behaviour of the chromatophores, the development of the antheridia, the form of the androcyte mother-cells, and the lengthwise orientation of the nuclear spindles all point to this conclusion. He believes that *Sphagnum* is a moss which in some way was adapted to meet periodic xerophil conditions, and lack of nutrition on moorland country. In which group the nearest relatives are to be sought is still a question.

**Structure of Aytonia.**†—Anna M. Starr gives an account of the structure of a Mexican species of *Aytonia* (= *Plagiochasma*). In summing up the results of her investigation of this hepatic, she says that:—1. Two appendages may be present on the ventral scales. 2. Rhizoids are absent among the first pairs of ventral scales. 3. Old

* Svensk. Bot. Tidskr. ix. (1915) pp. 261–93 (1 pl. and figs.). See also Bot. Centralbl., cxxix. (1915) pp. 672–4.

† Bot. Gaz., lxi. (1916) pp. 48–58 (4 pls. and figs.).

rhizoids are often replaced by new ones that form within them. 4. Fungi are prevalent in the compact tissue of the thallus. They both enter and may pass out through the rhizoids. No "pseudoparenchyma" was found. 5. The secretion of mucilage seems to have nothing to do with the "protection" of the growing point, but to be most pronounced about the egg and the antheridia. 6. Pitted cells show no tendency to become trachea-like. 7. The origin of air-chambers in the thallus and receptacles is schizogenous. The horizontal increase in the size of the chambers is due to the tearing of the tissues. The pore of the chambers of the thallus and of the antheridial receptacle is simple, but that of the archegonial receptacle has an elaborate margin. 8. The development of the sex organs follows the Marchantiales type. The archegonia form early in the history of the receptacle and parallel the increase in size of the receptacle by great increase in length of the neck. Following fertilization an exceedingly massive venter is developed about the embryo. 9. Five archegonia may begin to develop on one receptacle, but no more than three come to maturity. 10. The condition of the cells of the foot and of the adjacent parts of the thallus indicate the parasitic nature of the sporogonium. No elaterophore appears.

**Podomitrium.***—D. H. Campbell gives an account of the morphology and systematic position of *Podomitrium*. There are two species—*P. Phyllanthus* in Australasia, and *P. malaccense* in the Malay region. The anatomy of the thallus accords with *Blyttia*, and in most respects the author finds the genus to approach most nearly to *Blyttia*, but not in the position of its reproductive organs, nor in the presence of a definite foot in the sporophyte, and of a distinct elaterophore; moreover it has a different method of dehiscence. Cavers's suggestion that the families Aneuraceæ and Blyttiaceæ should be combined is good; for no constant characters are available for distinguishing them from one another.

**Mosses of Lake Takern in Sweden.**†—H. W. Arnell and C. Jensen publish the result of their investigation of the moss vegetation of Lake Tåkern in Oestergötland, Sweden. In the middle of last century a sinking of the water level took place; and when lately the question of a further sinking arose, an investigation was made as to the natural phenomena which would be thereby endangered. The authors were requested to undertake the mosses. Their report deals principally with the ecological conditions. The moor adjoining the lake is also dealt with, the moss vegetation being totally different. In the systematic treatment of the species recorded, the *Aduncum* group of *Amblystegium* receives detailed attention.

**Mosses of Madagascar.**‡—F. Renauld and J. Cardot have issued the text of their great work on the mosses of Madagascar, the atlas of

* Amer. Journ. Bot., ii. (1915) pp. 199–210 (figs.).

† K. Svenska Vetensk. Sjön Tåkern faun. flor., i. (1915) pp. 1-37. See also Bot. Centralbl., cxxix. (1915) pp. 669–71.

‡ A. and G. Grandidier, Histoire Phys. Nat. Madagascar, xxxix. (Paris, 1915) 564 pp.

which (with 163 plates) appeared in parts between 1898 and 1905, and a supplement of 24 plates in 1913. The text forms a thick quarto volume, with an introduction of 40 pages treating of the climate, the moss-flora, distribution, etc.; and a systematic part with descriptions of, and critical remarks on, all the species, including a number which are new to science, also keys to the species of some of the more troublesome genera.

**Mosses of New Hebrides.***—V. F. Brotherus and W. W. Watts give an account of the mosses collected by missionaries at various dates in the islands Aneityum, Futuna and Santo of the New Hebrides—a moss-flora of which little was known previously. One hundred and thirty-seven species are enumerated; and thirty-three of these are new to science. The flora shows an affinity with that of Papua and the Malay Islands, as well as with that of Fiji and Samoa.

**Mosses of the Philippine and Hawaiian Islands.**†—R. S. Williams gives an account of fifty-seven mosses from the Philippine Islands and four from Hawaii, collected by the late J. B. Leiberg, and describes the structure of four new species belonging respectively to the genera *Dicranella*, *Barbula*, *Hymenostomum*, and *Claopodium*.

## Thallophyta.

### Algæ.

(By Mrs. Ethel S. Gepp.)

**Alternation of Generations.**‡—C. Janet publishes an account of the sporophyto-gametophytic alternation of generations in the Algæ, in which he defines the holophyte and the orthophyte; and discusses instances of Algæ, whose orthophyte exhibits no alternation of generations (*Eudorina*, *Volvox*, Diatomeæ, *Fucus*); also of Algæ, whose orthophyte does present sporophytic-gametophytic alternation (tetrasporiferous Rhodophyceæ, *Spirogyra*); also *Ulothrix zonata*, an alga representative of the ancestral form in which is established sporophyto-gametophytic alternation. The discussion is set forth with much detail and explanatory tables, and with the creation of new terms for the more accurate expression of the author's meaning.

**Volvox.**§—C. Janet, in a preliminary note on the egg of *Volvox globator*, states that:—1. The constituent merisms of the orthophyte of *Volvox* are, without exception, "blastéas." 2. The "blastéa" which constitutes the female "téléomerisme" of *Volvox*, and which is composed

* Journ. Proc. Roy. New South Wales, xlix. (1915) pp. 127–57.
† Bull. Torrey Bot. Club. xlii. (1915) pp. 571–77.
‡ L'Alternance sporophyto-gamétophytique de générations chez les Algues. Limoges: Ducourtieux et Gout (1914) 108 pp. (figs.).
§ Note préliminaire sur l'œuf du *Volvox globator*. Limoges: Ducourtieux et Gout (1914) 12 pp. (figs.).

of a single evolutive oosphere and of a spherical follicle, composed of a great number of abortive oospheres, is homologous with "téléomerismes," which have themselves also the value of "blastéas," and are composed of eight evolutive oospheres in *Fucus*; of four evolutive and four abortive in *Ascophyllum*; of two evolutive and six abortive in *Pelvetia*; of one evolutive and seven abortive in *Himanthalia*; of one evolutive and three abortive oospheres or polar globules in animals. 3. The ontogenesis, certainly meiotic, of the female "téléomerisme" of *Volvox* is homologous with that meiotic ontogenesis which one calls the maturation of the egg in animals. 4. The oosphere of *Volvox* is homologous with that of animals. The peripheral follicular stratum of abortive cells which envelops the oosphere of *Volvox* is quite comparable with the group of three polar globules in animals. It is only the small number and small size of these globules which gives them the appearance of corpuscles rejected by the egg. Morphologically they represent plastids resulting from the ontogenesis of a "blastéa," a reduced ontogenesis, in the Fucaceæ, with three bipartitions producing eight oospheres, all or partly evolutive; and in the Animal, with two bipartitions producing four oospheres, only one of which is evolutive, while the three others are abortive.

**Euglena sanguinea.***—E. Naumann instances *Euglena sanguinea* as an example of plankton production in the Swedish ponds. He uses the microphotographic method of determining its quantitative occurrence at Aneboda in South Sweden. The first photograph shows the alga in its different stages of extension and contraction; No. 2 shows an irregular diffuse distribution (production per sq. mm. about 150); No. 3 the centre of a free-floating colony of *E. sanguinea*; and No. 4 the microphysionomy of the red surface of the alga (production per sq. mm. about 300).

**Algological Notes.**†—G. S. West publishes a further instalment of his Algological Notes:—XVIII. *Chlamydomonas microscopica* is proposed in place of *C. gracilis* for the plant described in Note XIV. XIX. The genus *Protococcus* C. Ag. (1824) having been proved by Wille to be valid, the name *Pleurococcus* must be dropped. Seven well-established and three less definite species are enumerated. XX. *Platymonas tetrathele* (both genus and species being new) is described. It developed abundantly, in April and May 1915, in a saltwater tank used for cultivating crabs. It belongs to the Carterieæ, a sub-family of Volvocaceæ. XXI. *Chlamydomonas brachyura*, a new species, is described. It developed in the same tank with *Platymonas*. *C. palatina* Schmidle was found in a ditch at Harborne; *C. Holdereri* Schmidle in a tub at Hereford; and *C. Grovei*, a new species, in a water-butt at Studley Castle, and at Cambridge. XXII. *Pteromonas angulosa* Dang. and *P. Takedana*, a new species, are described and carefully distinguished. XXXIII. An abnormal form of *Closterium Ehrenbergii* is discussed.

* Skrift. södra Sveriges Fiskerförening, (1914) No. 12, 16 pp. (4 pls.). See also Bot. Centralbl., cxxxi. (1916) p. 37.

† Journ. Bot., liv. (1916) pp. 1–10 (figs.).

**A New Chlorella.***—H. Kufferath has studied the nutrition of *Chlorella* by means of organic bodies. The species experimented on was *C. luteo-viridis* Chod. var. *lutescens* Chod. Experiments have been carried out in different nutritive liquids, the composition of which is described. The author has remarked that, in different solutions, *Chlorella* may vary within limits both as regards form and dimensions. The greatest modifications of dimensions takes place in carbohydrates and gums. They are much more pronounced in light than in darkness, and are principally in the form of growth. The form, under certain conditions which are described, may become ovoid, irregularly polyhedral, or pear-shaped. The author discusses also the reserve substances of *Chlorella*, when cultivated in a sugar solution. Under these conditions the pyrenoids, which are normally sufficiently constant to serve as a basis for classification, may disappear and give place to glycogen. This first accumulates round the pyrenoids, then in the chromatophores, and is capable of giving rise to oily drops, if exterior conditions become less favourable to the life of the alga. A very complete bibliography is appended concerning the organic nutrition of Algæ.

**Microthamnion.†**—J. Greger describes the development and reproduction of the genus *Microthamnion*. For want of knowledge of its method of reproduction, its systematic position has been uncertain. Various authors have placed it in Ulotrichaceæ, Chroolepidaceæ, and Chætophoraceæ. The author establishes its position in the last of these orders. His results are as follows:—*Microthamnion* forms small pale-green clumps plentifully and irregularly branched, either di- or trichotomously. Branches stiffly erect, adpressed or free. Cells 3-6$\mu$ wide, up to twelve times as long. Membrane very thin and unstratified. Chromatophore pale-green, ribbon-shaped, and lying against the cell-wall. Pyrenoids wanting. Nucleus single. Oil is formed as a product of assimilation. Reproduction takes place by macrospores, from which the young plantlets arise direct without previous copulation. The dividing membranes of the lateral branches from the main stem are not at the point of junction, but are formed somewhat higher in the lateral branch by successive growth. The macrospores are long and pyriform, possess two cilia of equal length, a pale-green chromatophore and a red eye-spot. Under certain conditions (lack of water, etc.) a formation of akinetes takes place. Finally, the author compares *Microthamnion* with *Pleurococcus*, *Stigeoclonium*, and *Leptosira*. He recommends caution in determination of species.

**Diatoms of Finland.‡**—A. Cleve-Euler makes new contributions to the Diatomaceous Flora of Finland. The diatoms of that country were worked out in 1891 by P. T. Cleve, since which time very few

* Rec. Inst. Bot. Léo Erréra, ix. (1913) pp. 113–319 (4 pls. and figs.). See also Bull. Soc. Bot. France, lxii. (1915) pp. 86–8.

† Hedwigia, lvi. (1915) pp. 374–80 (1 pl.). See also Bot. Centralbl., cxxxi. (1916) p. 78.

‡ Arkiv Bot., xiv. (1915) 81 pp. (4 pls.). See also Bot. Centralbl., cxxxi. (1916) p. 4.

additions have been made. The present author has, however, had access to samples of marine, freshwater, sub-fossil, and recent species, and has added largely to the number recorded. She establishes a new ecological group of diatoms—i.e. a marine-arctic formation. Many new species are described and figured.

**Algæ of the Missouri Botanical Garden.***—A. Hayden describes the algal flora of the Missouri Botanical Garden, enumerating the species of algæ, and describing and figuring the different localities. Observations are given on the following species:—*Botrydium granulatum*, *Spirogyra longata*, *S. porticalis*, *S. tenuissima*, *Chlamydomonas glœocystiformis*, *Tetraedron trigonum*, *Stigeoclonium glomeratum*, and *Pithophora Mooreana*.

**Cladophora in Deep Water.**†—E. M. Kindle gives an account of a *Cladophora* found growing on curiously corroded limestone ("honeycomb rock") at the remarkable depth of 150 feet in Lake Ontario. Upon investigation the alga was determined as *Cladophora profunda* Brand, which occurs in the lakes of the Bavarian Alps, at depths not exceeding 50 feet. The plant is a new record for America, and is distinguished as *forma ima* from the European type.

**Mougeotia.**‡—R. Chodat publishes the second of his studies on the Conjugatæ. The subject is the copulation of *Mougeotia*. He begins by quoting the general view as expressed by Oltmanns, that *Sirogonium*, *Mougeotia*, and other algæ, produce knee-like out-growths which form contact with one another and coalesce. This view is shown to be incorrect. Contact is necessary for the production of copulative anastomoses, and as copulation advances, so the knee-like outgrowths increase in size. As many as three filaments connected by anastomosis have been observed. The formation of an azygospore is also described and figured. Its production might be attributed to a general influence, bringing into play the formation of copulative branches, which, failing a vis-à-vis, were transformed into a zygote. But if the course of the azygospore filament be followed it is seen that copulation has taken place on that filament; and the formation of the azygospore is probably the result of the impetus there given. The result of the investigation shows that the exciting cause of the copulative anastomoses is contact, haptotropism. Nevertheless it is evident that sensibility to contact is not constant, since the filaments are continually in contact without the production of a zygote. The sensibility is an affair of maturation. The necessary condition must be present, and the key to that is at present unknown.

**Development of Saccorhiza bulbosa.** —C. Sauvageau describes the germination of *Saccorhiza bulbosa*, and the first stages of the developing plantlet. After swimming about for some time, the zoospore comes

* Twenty-first Ann. Rep. Missouri Bot. Garden, 1910, pp. 25–48 (5 pls.).
† Amer. Journ. Sci., xxxix. (1915) pp. 651–6 (figs.)
‡ Bull. Soc. Bot. Genève, sér. 2, v. (1913) pp. 193–5 (figs.).
§ Comptes Rendus, clxi. (1915) pp. 740–2.

to rest, rounds itself off, becomes enclosed in a membrane, and passes into the condition of an embryospore. Then the embryospore doubles its diameter without changing its form and multiplies its chromatophore, while the nucleus remains single. It then becomes elongated into a tube of the same width or narrower, and a length of several times its diameter. The zoospore contents soon leave the posterior extremity and accumulate in the young extremity. They break the membrane and escape in a naked uninucleate mass, slightly elongated, which rests on the opening of the tube of the empty embryospore, becomes surrounded with a membrane, and grows rapidly. This is the orgin of the plantlet. This plantlet applies itself to, and moulds itself so exactly on, the mouth of the empty tube, that it looks as if the contents of the embryospore had simply moved up and separated themselves by a cell-wall from the abandoned posterior portion. One zoospore provides in this way one individual. This may be regarded as the normal mode of germination. If the embryospore divides its nucleus in two and a dividing wall is formed, the contents of the anterior cell escape and germinate. If it becomes a monosiphonous filament of several uninucleate cells, it is generally the contents of the anterior cell again which provides the plantlet; and if the rest of the filament continues to grow instead of perishing, it may produce another backward plant. Finally, there are cases of slow-growing cultures, in which the embryospore emits upright branches, each of which may produce a plantlet by the same process. In this way a zoospore produces at least two individuals.

The development of the plantlet begins at once and is continued unceasingly. The details are as follows:—The unicellular plant, as a rule adhering to the neck of the embryospore membrane, divides transversely about the middle; each half increases in size and again divides transversely. In this quadricellular plant the two superior cells are broader than the others and divide by a median longitudinal wall. Their importance is, however, less than that of the inferior cells which each divided into two. The further divisions of these cells are described and figured, and the part that each plays in the further development of the plant is indicated. The growth of the plantlet is simultaneously stipofrondral and intercalary, as in the adult plant.

**Heterogamic Sexuality of Saccorhiza bulbosa.***—C. Sauvageau records for the first time among the Laminariaceæ a heterogamic sexuality with alternation of generations. In a previous paper he describes the development of *S. bulbosa*,† and notes the presence of a naked mass of protoplasm; this mass is an oosphere, and the embryospore, either unicellular or pluricellular, which provides it is the female gametophyte. With this there appears constantly a male gametophyte smaller in size. The author made his first cultures in March 1914. They were repeated many times and were always free from Phæosporeæ. Nevertheless, although all the zoospores appeared identical, there always appeared several days after dehiscence an unknown brown alga.

* Comptes Rendus, clxi. (1915) pp. 796–9.
† Comptes Rendus, clxi. (1915) p. 740.

Various methods of culture were tried with invariably the same result, and as the invariable presence of an intruding plant of Phæosporeæ is improbable in the extreme, it is evident that the germinating plant results from the *Saccorhiza* zoospore. Two sorts of germination arise from the zoospores of the same sporangium. In the author's preceding note he discussed and described the female gametophyte. Here he describes and figures the male gametophyte. The antheridia arise as buds, round and colourless, on cells well coloured with chromatophores; the apex becomes pointed in the form of a short beak, or the swollen membrane forms a cork: they measure 7 $\mu$–9 $\mu$ by 4 $\mu$–5 $\mu$, and contain a single antherozoid. A pale red-orange point has often been noticed, but its presence is not constant. In certain preparations motile elements, uncoloured, provided with two lateral cilia have been seen, resembling the antherozoids of certain species of *Cystoseira*, and which could only belong to *Saccorhiza*. The element produced by the antheridia is evidently fertilizing: the female element is furnished by the embryospores which increase in size, and the oosphere is the protoplasmic mass which escapes from it. The plantlet is then the result of fertilization. Thus it is seen that *Saccorhiza* and probably all the Laminariæ possess a heterogamic sexuality with alternations of generations. The number of the chromosomes has not been observed. The phenomenon differs so much from that known among the Phæosporeæ, that the Laminariaceæ must constitute a group of the Brown algæ of the same systematic importance as Fucaceæ and Dictyotaceæ.

**Size of Kelps on the Pacific Coast of North America.***—T. C. Frye, G. B. Rigg, and W. C. Crandall have published the result of their investigations on the size of the kelps, made during many years. They do not confirm the statements of writers on the great length of *Macrocystis* and *Nereocystis*. The longest plant of *Macrocystis* found on the Californian coast reached 45·7 m., and the longest plant of *Nereocystis* reached 38·4 m. *Pelagophycus porra* has been found 45 m. in length on the Californian coast. The observations of the authors on *Alaria fistulosa* confirm earlier statements of its length. Its maximum width was found to be more than twice as great as reported in literature, the widest plant observed being 75 c.cm.

**Marine Algæ of the Danish West Indies.**†—F. Boergesen publishes the first instalment of his second volume of the Marine Algæ of the West Indies. It consists of part of his treatment of the Rhodophyceæ, and contains also Introductions and Indices to the previously published Chlorophyceæ and Phæophyceæ. Many new species are described and all the records are discussed at length and figured. Twenty-one species are described for *Acrochætium*, each of them being treated with monographic detail. The genus *Nemalion* is completed and *Liagora* is begun in the present part.

* Bot. Gaz., lx. (1915) pp. 473–82 (figs.).
† Marine Algæ of the Danish West Indies, ii. (1915) pp. 1–80. Copenhagen: B. Luno.

**Algæ from the Falkland Islands.***—A. D. Cotton publishes a complete list of the marine algæ of the Falkland Islands, based primarily on the collections made there by Mrs. Vallentin, and supplemented by any previous records. Mrs. Vallentin's notes on the shores where the algæ were collected are given verbatim, and contain interesting information. During a severe gale many tons of algæ are torn up and hurled ashore, and the writer records the fact that on several occasions during big storms, when the kelp was being torn up and the fronds and stems broken by the fury of the elements, the mucilaginous substance exuded from these broken algæ was so great that it had almost the effect of oil in smoothing the crests of the waves. This was at times so markedly the case that the rollers lost much of their danger. Mr. Cotton deals at length with the interesting problems of geographical distribution, and compares the marine flora of the Falklands with that of Kerguelen, the Australian region, and the Antarctic, respectively. He finds that the algal flora of the Magellan region is a subantarctic one of a distinct South American type. A systematic list of the species is given, and critical notes are appended to many of the records. Two new species are described. The Melobesiæ are described in a separate note by Madame Lemoine, accompanied by full critical notes. She describes one new species. A systematic list of the fresh-water algæ is given, compiled from Carlson's "Süsswasser-algen" (1913).

**Japanese Algæ.†**—K. Yendo publishes a third chapter of notes on Algæ new to Japan, founded on the knowledge gained from an inspection of the principal algological herbaria in Europe. The list comprises species of *Enteromorpha* (2), *Prasiola*, *Urospora*, *Spongomorpha*, *Cladophora*, *Bryopsis* (4), *Chantransia*, *Goniotrichum*, *Porphyra*, *Mychodea* (2), *Callophyllis*, *Rhabdonia*, *Tylotus*, *Plocamium*, (3), *Lophosiphonia*, *Farlowia*, *Rhododermis*. Critical notes on structure, reproduction, distribution, economic uses, are included.

**Oceanic Algæ.‡**—A. Mazza continues his studies of oceanic algæ, and describes the structure and morphology of three remaining species of *Dudresnaya*, also the genus *Dasyphloea* (two species) *Pikea* (one species), *Farlowia* (two species). *Andersoniella* (one species), *Baylesia* (one species). These genera belong to the family Dumontiaceæ.

## Fungi.

(By A. Lorrain Smith, F.L.S.)

**Achlya and Saprolegnia.§**—A. J. Pieters has discovered and now publishes new species of these two genera. He discusses the question as to the production or non-production of oogonia in some species, find-

* Journ. Linn. Soc., xliii. (1915) pp. 137–204 (7 pls.).
† Bot. Mag. Tokyo, xxix. (1915) pp. 99–117 (1 fig.).
‡ Nuov. Notar., xxvi. (1915) pp. 181–206.
§ Bot. Gaz., lx. (1915) pp. 483–90 (1 pl.).

ing that these fruits are formed when there is a scarcity of food supply. The three new species, *Achlya Klebsiana*, *Saprolegnia Kaufmanniana* and *S. monoica* var. *vexans*, were obtained in cultures from algal material. Diagnoses are given of these new forms.

**Protomycetaceæ of Switzerland.***—G. von Büren has published an account of this family as part of the Swiss Cryptogamic Flora. He adds many new observations to those already made on this small and obscure family. He has found that in *Protomyces macrosporus* and *P. pachydermus* the protoplasmic body that issues from the chlamydospore forms spore mother-cells which divide subsequently into four spores, and in the young chlamydospores he has proved paired nuclear fusion. In this family he recognizes four genera :—*Vollkartia*, *Taphridium*, *Protomyces*, and *Protomycopsis*. Von Büren decides as to the systematic position of the family, that it is related to the Ascomycetes as the Ustilagineæ are to the Basidiomycetes.

**Variations in Hypomyces.**†—F. Vincens observed the growth of a superficial fungus on a *Lycoperdon* sp., partly immersed in formol. There were a few rare conidiophores and conidia formed of the *Verticillium* type, proving the connexion of the fungus with *Hypomyces*. He describes the continued growth of the mycelium not only on the puff-ball, but in the solution as well. Chlamydospores were formed, both intercalary and terminal. Fresh cultures were made on gelatin which proved that the influence of the formol persisted through several generations.

**Conidial Form of Ophiobolus herpotrichus.**‡—This parasite of wheat-stalks has been supposed to possess two conidial forms : *Hendersonia herpotricha* and *Fusarium rubiginosum*. E. Vosges has by culture experiments proved that neither of these Hyphomycetes form part of the life-cycle, but that *Acremonium alternatum* is the conidial stage. The mistake has arisen in that the diseased stalks bear constantly a number of fungi, including the two species quoted above.

**North American Species of Ascodesmis.**§—F. J. Seaver has determined two species of the genus *Ascodesmis* which is new to the American flora. The first *A. microscopica*, hitherto known as *A. nigricans*, grows generally on the excrement of dogs and tigers. The second species, *A. porcina*, occurred on excrement of pig sent from Porto Rico, New Jersey. Other excrement was put in culture and the same fungus was developed, proving that the particular substratum is of first importance in the production of the fungus. Both species are minute Ascomycetes with brown or dark spores, becoming rough at maturity.

* Beitr. Krypt.-Flora Schweiz, v. No. 1 (1915) 103 pp. (7 pls.). See also Bot. Centralbl., cxxix. (1915) pp. 226–7.

† Bull. Soc. Bot. France, lxii. (1915) pp. 59–64 (1 pl.).

‡ Centralbl. Bakt., xlii. (1915) pp. 49–64 (9 figs.). See also Bot. Centralbl., cxxix. (1915) pp. 30–1.

§ Mycologia, xiii. (1916) pp. 1–4 (1 pl.).

**Podosporiella Disease of Germinating Wheat.***—The fungus, which causes a new disease of wheat, was found in the wheat-fields of Salt Lake City by P. J. O'Grady. The wheat-kernels were infected, and their contents destroyed at or near the time of germination, the interior of the grains being filled by a dark brown septate mycelium. It does not attack any other part of the host-plant, and cannot be considered a parasite, as it destroys only the contents of the grain. The plant is still able to germinate, but the seedlings are weak, and seemingly never recover vigour. The fungus was diagnosed and described as *Podosporiella verticillata* sp. n. Upright conidiphores bear at their tips a whorl of elongate septate brown conidia.

**Dissemination of Endothia Spores.**†—F. D. Heald, M. W. Gardner and R. A. Studhalter have made experiments in the spread of the chestnut-blight fungus. As a result of exposure-plates they have proved definitely that ascospores are in the air, and are carried varying distances from their source; they are much more abundant in wet weather, and in some cases the maximum of ascospore expulsion occurs after the cessation of rain. Pycnospores are not generally prevalent in the air at any time, so that dissemination of the disease is mainly due to wind-transport of the ascospores, and after each warm rainfall ascospores are ejected and carried away in great numbers.

**Chrysomysca expansa Dietel.**‡—The type specimen of this species was collected on *Rhododendron japonicum*. Later it was found also on other rhododendrons. K. Miyabe gives an account of the distribution of the host-plants, and of the appearance of teleutospores and uredospores, with the time of their development. It is a heterœcious form, and the alternate æcidium or *Peridermium* stage grows on the leaves of *Picea ajanensis*, and is known as *Peridermium Piceæ-hondonensis*. This was proved by infection from host to host of the teleutospores and æcidiospores.

**Uredineæ.**—Marcel Mirande § has determined a new host for *Uromyces Lilii*, viz. *Fritillaria involucrata*, a plant of S.E. France. æcidia and spermogonia are formed on both surfaces of the leaves, but more abundantly on the upper surface, in April and May, and are scattered about the middle of the latter month. Uredospores do not occur in this species.

P. Dietel ‖ gives an account of various experiments with the germinating teleutospores of *Puccinia Malvacearum*. They require a high degree of humidity; in an atmosphere below saturation point there was only a weak germination, and the germinating tubes remained

* Phytopathology, v. (1915) pp. 323–5 (2 pls.).
† Journ. Agric. Res. Washington, iii. (1915) pp. 493–526. See also Bot. Centralbl., cxxix. (1915) pp. 256–8.
‡ Bot. Mag. Tokyo, xxix. (1915) pp. 258–65.
§ C.R. Soc. Biol. Paris, lxxviii. (1915) pp. 530–1.
‖ Centralbl. Bakt., xlii. (1915) pp. 698–705. See also Bot. Centralbl., cxxix. (1915) pp. 27–8.

short and without forming sporidia. The author also observed that the first stage in germination was the extrusion of a naked mass of protoplasm from the spore, which later lays down the membrane of the promycelium. The sporidia also are at first minute naked points of protoplasm pressed out through a cleft on the apex of the sterigma by internal turgescence; the sporidial membrane is also formed later.

Other experiments were undertaken to determine the length of time that the sporidia could remain capable of germination. The capacity was of short duration in an atmosphere not thoroughly saturated. They lost all power of growth in an hour when the air was saturated to 90 p.c., and even in 100 p.c. of saturation they did not long remain vital. These experiments proved the impossibility of rust dissemination by means of sporidia to any great distance.

J. C. Arthur * publishes eleven new species of Uredineæ belonging to the genera *Uropyxis*, *Uromyces*, *Puccinia*, *Æcidium* and *Uredo*. Four of these are short cycle forms, and are interesting because they occur on hosts that also bear long cycle species.

B. O. Dodge † discusses the effect of the host on the morphology of certain species of *Gymnosporangium*. Special attention is given to *G. biseptatum*, which is perennial in the branches or trunk of *Chamæcyparis*, which is characterized by a great variability in the number of spore-cells; and *G. fraternum*, a folliculous parasite on the same host. He considers that these two, however, may be the same species, as their æcidia on *Amelanchier* are much alike. The discussion mainly deals with inoculation experiments of the two forms from one host to another.

Yellow Rust of Cereals (*Puccinia glumarum*) has recently been discovered in N. America by M. A. Carleton ‡ on several varieties of wheat in Arizona and also in other districts. Up to July it had not been found in any place east of the Rocky Mountains. It is a common rust in Europe.

J. C. Arthur § has given an account of the Uredinales of Porto Rico, based on collections made by F. L. Stevens. A few are new species; all those recorded are described at length, and an index is added of Uredinales of the West Indies, with an index to the host plants.

A. W. Borthwick and Malcolm Wilson ‖ describe two Rust Diseases of the Spruce:—*Chrysomyxa Rhododendri* was first discovered in Britain by D. A. Boyd in June 1913 at Douglas Castle, Lanarkshire. The æcidial stage on *Picea excelsa* was discovered in S.W. Scotland some months later. The life stage of the fungus was already well known. The disease is not likely to spread, as the species of Rhododendron on which it grows are rare. *Chrysomyxa Abietis* completes its life history on the Spruce, and is therefore a more dangerous rust. Though appearing only recently in Scotland it has already done considerable damage.

* Bull. Torrey Bot. Club, xlii. (1915) pp. 585-93.
† Bull. Torrey Bot. Club, xlii. (1915) pp. 519-42 (2 pls.).
‡ Science, n.s. xlii. (1915) pp. 58-9. See also Bull. Agric. Intell. Rome, vi. (1915) p. 1408.
§ Mycologia, viii. (1916) pp. 16-33.
‖ Notes Roy. Bot. Gard. Edinburgh, ix. (1915) pp. 63-9 (1 pl.).

F. D. Fromme* has published observations on the negative heliotropism of uredospore germ-tubes. He found that those of *Puccinia Rhamni* grew away from the light; when germinated in darkness, the tubes spread on all sides. Fromme suggests that this character may be of advantage in the many-pored uredospores in inducing germination from the side of the spore in shadow on the leaf, and thus rendering penetration of the host more direct and certain.

**Fungi producing Heart-rot of Apple-trees.**†—B. O. Dodge publishes results of his observations on this subject. He found apple-trees in old untended orchards with the heart-wood completely destroyed, though the tree was still fruit-bearing. One of the fungi identified as causing mischief was *Polyporus admirabilis*. It was first found growing out from a small spot in the sap-wood, and the line of decay was traced into the heart-wood, which was badly rotted. Various forms of this fungus was found at different localities, and another species, identified as *Spongipellis galactinus*, was also proved to cause mischief. It grows inside partially decayed trunks, or emerges from knot holes in living trees. *Polyporus spumeus* var. *malicolus* was recognized by C. G. Lloyd as the cause of heart-rot in apple-trees of New England, but further study and inoculation experiments are necessary.

**Fungi parasitic on Scale-insects in Formosa.**‡—K. Miyabe and K. Sawada describe seven species of these special fungi belonging to the genera, *Aschersonia Sphærostilbe* and *Ophionectria*, three of them new to science. They discuss the history and biology of these "coccophilous" fungi. One of them, *Sphærostilbe coccophila* Tul., which has the widest distribution, is a natural enemy of *Aspidiotus perniciosus* and of *Diaspis pentagona*. Of the two species of *Aschersonia* recorded which are parasitic as the scale-insects of orange-trees, one, *A. marginata*, is termed the "black fungus," and the other, *A. Aleyrodes*, is termed the red fungus. Another new species, *A. Suzukii*, was found parasitic on *Aspidiotus Aurantii*. *Microcera Fujikuroi* sp. n., and two species of *Ophionectria*, complete the list. They are all carefully described—the two latter, also, on orange-tree insects.

**Plants Immune to Fungi.**§—W. S. Hill gives an account of Prairie-grass (*Bromus unioloides*), which is the most valuable of the brome-grasses in New Zealand from an agricultural point of view, and a very superior type has been isolated which is immune to the Smut fungus, *Ustilago bromivora*. The plants yield a higher percentage of leaf, and are later in flowering than ordinary samples.

The second instance of immunity is a vine, known as Vidadico, and is strongly recommended by J. Fiso Torres,‖ as being resistant to Vine

* Amer. Journ. Bot., ii. (1915) pp. 82–5 (2 figs.).

† Mycologia, viii. (1915) pp. 5–15 (4 pls.).

‡ Journ. Coll. Agric. Sapporo, Japan, v. (1913) pp. 73–90 (2 pls.).

§ Journ. Agric. Wellington, New Zealand, x. (1915) pp. 313–19 (4 figs.). See also Bull. Agric. Intell. Rome, vi. (1915) p. 1478.

‖ Resumen Agric. Barcelona, 1915, pp. 436–8. See also Bull. Agric. Intell. Rome, vi. (1915) pp. 1536–7.

mildew, *Plasmopara viticola*. It resisted infection in such a bad mildew season as 1915. It grows well on land not too high nor cold, and not too liberally irrigated. The wine from its grapes keeps well and is of good quality.

**Notes on Australian Fungi, No. II.***—J. Burton Cleland and Edwin Cheel give an account of Phalloids and Geasters, supplementing C. G. Lloyd's Phalloids of Australasia. The authors, from public and private collections, are able to confirm and add notes to Lloyd's descriptions. They give full accounts of all the species, and they add a list of Phalloids as amended by them, which includes ten genera and twenty species. They have studied the Geasters with equal care, and publish a final list of some twenty-two Australasian species.

**Effects of the Brown-rot Fungus on Peach.**†—L. A. Hawkins describes his experiments on peaches which he inoculated in the laboratory with the fungus *Sclerotinia cinerea* taken from pure cultures. When the fruit was half-rotted it was split in two and the contents of the halves analyzed and compared. Hawkins describes the process of examination and the results :—"The pentosan content remains practically the same, the acid content is increased, the amount of alcohol-insoluble substance which reduces Fehling's solution when hydrolyzed with dilute hydrochloric acid decreases, the total sugar content decreases, while the cane-sugar practically disappears."

**Plant Diseases.**‡—T. Petch has published a note on the occurrence of *Citrus* mildew in Ceylon, where it is a common disease. It covers the leaves and young shoots at the end of the Monsoon with a thick white coating, and in some districts kills back the trees so regularly that they never grow up. Mildews or their *Oidium* stages are very common in Ceylon, but no perithecial stage of *Erysiphe* has yet been found.

Diseases of Peas due to Mildews, &c.,§ have been described and methods of control advised. *Erysiphe Polygoni* attacks young pea plants and they die off as maturity is reached—leaves, pods, and stems being covered with the fungus. Spraying, to be effective, should be begun early. *Peronospora Viciæ*, the pea mildew, also attacks the growing plant and destroys the leaves, covering them with a delicate white mould. All diseased material should be burned in this case, and rotation of crops is desirable. *Uromyces fabæ* or rust attacks not only peas but broad beans and various vetches and plants belonging to the pea family. The plants are first attacked in spring; winter spores which carry on the life of the fungus are formed in autumn. Spraying is of no avail; all infected plants should be burned. *Ascochyta Pisi* attacks the leaves and pods, and the latter often become more or less contorted and seeds are not formed. Spraying is desirable, as it holds the parasite in check. *Phytophthora* sp. (probably *Ph. omnivora*)

* Journ. and Proc. Roy. Soc., xlix. (1915) pp. 199–232 (2 pls.).
† Amer. Journ. Bot. ii. (1915) pp. 71–81.
‡ Phytopathology, v. (1915) pp. 350–1.
§ Board of Agric. Leaflet, No. 287 (1915) 4 pp.

blackens the collar or neck of the attacked plants and rotting of the tissues very soon follows. Watering the soil with formalin is recommended.

P. C. van der Wolk * describes a wound parasite of *Manihot utilissima* that appeared in the gardens at Buitenzorg and threatened considerable damage, but was finally checked by applications of tar. The cause of the disease was discovered to be a new species of *Stagonospora* that spread with great rapidity in the wood and bast elements. Artificial cultures on rice were successfully made, and the development of mycelium on pycnidia. Endospores were formed within the mycelium either singly, in rows, or in masses.

R. S. Hole † describes the ravages of *Trametes Pini* in India, where it is mainly confined to *Picea excelsa*. Infection usually takes place by wounds by means of wind-borne spores. He recommends clearing away all diseased trees, and care in closing any wounds, and also the planting of mixed woods as giving less opportunity to spread of any one disease.

A disease of lime-trees due to the fungus *Glœosporium tiliæcolum* has been long known on the Continent, and has appeared recently in a garden at Bearstead, near Maidstone, Kent, and is described by E. S. Salmon ‡ It attacks leaves, petioles and young shoots, and even the inflorescence and the young bracts. Well-defined spots indicate the diseased areas, and these are dotted over by the dark pustules of the fungus.

G. Arnaud § reports the appearance in France of *Sclerospora macrospora* on wheat. The specimens were in the last stage of the disease as far as the leaves were concerned ; the awns also showed distortion. The fungus is known to attack various other grasses.

A severe attack of *Monilia cinerea* is described by J. Chifflot and Massonat ‖ in the Department of Isère. It affects standard apricot trees just after flowering, causing the death of the twigs which it attacks. Methods of treating and preventing the disease are recommended, mainly the removal and burning of all diseased branches, etc.

W. N. C. Belgrave ¶ records a disease of Mangosteens due to *Zignoella Garciniæ*. It causes canker in the bark, which may encircle and kill the branches, and finally the tree. The pycnidia of a species of *Hendersonia* are often found associated with cankers, and are probably part of the life cycle of *Zignoella*. Felling the diseased trees and carefully burning all diseased parts is the only means of treatment.

James R. Weir ** publishes notes on the fungi that attack the Jack-

* Mycol. Centralbl., v. (1914) pp. 225–30 (10 figs.). See also Bot. Centralbl., cxxix. (1915) pp. 31–2.

† Indian Forest Records, v. (1915) pp. 159–84 (7 pl.).

‡ Gard. Chron., lviii. (1915) pp. 193–4.

§ C.R. Acad. Agric. France, i. (1915) pp. 429–35 (2 figs.). See also Bull. Agric. Intell. Rome, vi. (1915) pp. 1407–8.

‖ Rev. Horticole, lxxxvii. (1914–15) pp. 540–1. See also Bull. Agric. Intell. Rome, vi. (1915) pp. 1409–10.

¶ Agric. Bull. Federated Malay States, iii. (1915) p. 229. See also Bull. Agric. Intell. Rome, vi. (1915) p. 1410.

** Bull. U.S. Dept. Agric., No. 212 (1915) 10 pp. (1 pl. and 4 figs.). See also Bull. Agric. Intell. Rome, vi. (1915) pp. 1410–12.

pine (*Pinus divaricata*). The greatest damage is done by *Peridermium cerebrum*, which causes gall-like excrescences on the trunks and branches. Young trees are often covered with swellings which are very injurious to their growth. The oak tree is the alternate host, and a due watch must be kept in the forests for both stages of the fungus. Older trees are attacked by *Trametes Pini* and by *Polyporus Schweinitzii*. *Fomes annosus* and *Armillaria mellea* occur rarely: *Lophodermium pinastri* occasionally attacks the leaves.

Alf. Lendner * has given an account of a disease of the vine due to a *Hypochnus* sp. n. It was localized round stem nodules caused originally by frost, and forms a white felt. The author did not find that it was the cause of very serious damage.

Esther Young † has published a report on species of a *Cercospora* parasitic on plants in Porto Rico. It is a leaf genus of fungi. Six new species are added to those already known.

W. B. Mercer ‡ writes on an outbreak of mildew that attacked greenhouse carnations in the Tyne Valley, and threatened to become serious, but was held in check by repeated sprayings. The disease is characterized by the appearance on the leaves of patches of white mould, which gradually spread and assume a yellowish hue. Though living on the outside of the plant this species of *Oidium* was found to bore its way through the cuticle by means of the haustorium. Inside the epidermal cell it becomes distended into a sacculate ending; several such haustoria were frequently found in one cell. The perithecium of the fungus has not been observed. Directions are given as to the means of combating the disease by different spraying solutions.

A general review § of Plant Diseases in England and Wales for 1914–15 has been issued instead of the annual reports of the Horticulture Branch of the Board of Agriculture. The report deals especially with American Gooseberry Mildew, Warts, Disease of Potatoes and Corky scab of Potatoes. Accounts are given of the prevalence of these diseases during the period, and of the means taken to check the ravages of the fungi by which they are caused. In all cases the diseases were well under control.

## Lichens.

(By A. Lorrain Smith, F.L.S.)

**Teloschistes in N. America.**‖—R. Heber Howe gives a detailed account of the three species of this genus that occur in N. America. The two first, *T. flavicans* and *T. chrysophthalmus*, are also British. The former he ranks as maritime, the latter has a much wider distribution. *T. villosus*, of which the type specimen came from Peru, occurs in Lower California.

* Inst. Bot. Univ. Genève, sér. 9, i. (1915) pp. 26–8 (1 fig.).
† Mycologia, viii. (1916) pp. 42–6.
‡ Journ. Roy. Hort. Soc., xli. (1915) pp. 227–9 (figs.).
§ Journ. Board Agric., xxii. (1916) pp. 931–7.
‖ Bull. Torrey Bot. Club, xlii. (1915) pp 579–83 (2 figs.).

**A Westmorland Lichen.***—J. A. Wheldon describes specimens of *Pilophorus cereolus*, which he collected at Great Langdale, covering the perpendicular surface of a large rock. The spores in this specimen are of a larger size than those given by Crombie for the species, and the specimens seem to form a connecting link between *P. cereolus* and *P. fibula*, with larger spores.

**Umbilicariaceæ.**†—Hue has published an account of this family, in which he has made some changes. He gives lengthy descriptions of two species of *Dermatiscum*, and arranges the genera thus:—1, *Omphalodium*; 2, *Charcotiæ* (gen. nov.); 3, *Umbilicaria*; 4, *Dermatiscum*; and 5, *Entosthelia*. The genus *Charcotia* has a thallus similar to that of *Umbilicaria*, but the apothecia have a thalline margin. There is one species, *C. rufidula*. He also considers that the thallus of *Dermatocarpon* is similar to that of *Umbilicaria*, and removes it to his genus *Entosthelia*. The character of the fruit, which is pyrenomycetous, Hue considers as of secondary importance. Two new species in *Pannaria* and *Buellia* are also described.

## Mycetozoa.

(By A. Lorrain Smith, F.L.S.)

**Myxomycetes from South America.**‡—W. C. Sturgis states that the number of species known from that vast continent is comparatively small. He has found it of interest, therefore, to examine and report on a collection of species made by Professor Roland Thaxter in Argentina and Chile. A fairly large number are listed, and any points of interest are added to them. He adds that:—"It will be noted that, although the list includes several interesting species, it has been unnecessary to record any new species."

## Schizophyta.

### Schizomycetes.

**Longevity of Soil Micro-organisms under Desiccation.**§—Ward Giltner and H. Virginia Langworthy, after an historical review, give the results of an experimental study of soil-solutions containing a slime, and its effects on the desiccation of certain bacteria, as a food material or as a protective during desiccation, the species chiefly investigated being *Pseudomonas radicicola*. It was found that during the period of desiccation spore-bearers largely increase in proportion as the non-spore-bearers die out. Of the latter a species which occurred most numerously and showed the greatest longevity, and one of the slime-formers, are described. The authors conclude that: 1. The survival of non-spore-bearing bacteria in air-dry soil is due in part to

* Lancashire Naturalist, viii. (1916) p. 343.
† Bull. Soc. Bot. France, lxii. (1915) pp. 13–23.
‡ Mycologia, viii. (1916) pp. 34–41.
§ Journ. Agric. Research, v. (1916) pp. 927–42.

the retention by the soil of moisture in the hygroscopic form. 2. Bacteria resist desiccation longer in a rich clay-loam than in sand. 3. If bacteria, before being subjected to desiccation in sand, are suspended in the solution extracted from a rich clay-loam, they live longer than after suspension in physiological salt solution. 4. Such clay-loam solution contains substances which have a protective influence upon bacteria subjected to desiccation.

**Liquefying Fluorescent Bacillus.***—M. A. Botez obtained from a bed-sore of a tabetic, and also from the patient's blood, a liquefying fluorescent bacillus, which was agglutinated by the patient's serum in the proportion of 1–200. The bacillus is motile, and while some of the rodlets stain by Gram's method, others do not. Most of the media were coloured green or yellowish, but the pigment was not extracted by chloroform. Gelatin and blood serum were liquefied. The organism was found to be highly pathogenic to rabbits and mice.

**Tuberculosis in the Pig.†**—M. P. Chaussé gives in these two papers an interesting study of the special features of porcine tuberculosis. As the result of his investigations the author is persuaded that the pig is almost without exception infected through the tonsils and cervical lymphatic glands, the explanation probably being that these animals are usually fed on waste milk, mixed from various sources. Other animals —man, the ox and the dog—are usually infected with tuberculosis by inhalation. The commonest lesions are met with in the peripheral lymphatic glands and bony structures; the kidneys, as with man, the ox, the dog, and the guinea-pig, are rarely involved. Pneumonic lesions are only met with when the condition becomes generalized, in which stage of the disease the lungs, in common with the liver and spleen, become much affected. The pig is exceedingly sensitive to tuberculous infection, the encysted and latent lesions so commonly met with in other animals being the exception rather than the rule, while generalized infection, which is relatively uncommon in the ox and in man, is the form of porcine tuberculosis most commonly seen. Retrogressive changes and fibrous encapsulation do not therefore occur, but on the other hand caseation is early and frequently met with. To sum up, porcine tuberculosis is mostly of the bucco-pharyngeal type, while human and bovine tuberculosis are mostly of the inhalation type; the proportion between the two moods of infection in each case being determined by the varying conditions under which the infective material is introduced.

**Sporotrichum Beurmanni as a Saprophyte of Wheat.‡**—A. Sartory has isolated from an ear of corn a species of fungus which answers in all its morphological and cultural characters to the human parasite *Sporotrichum Beurmanni* (de Beurm. and Goug.). The virulence of the fungus for the rat was at first *nil*, but by means of passage from animal to animal, a rapid and fatal septicæmia was finally obtained.

* C.R. Soc. Biol. Paris, lxxix. (1916) pp. 89–90.
† Ann. Inst. Pasteur, xxix. (1915) pp. 556–600, and 633–47.
‡ C.R. Soc. Biol. Paris, lxxviii. (1915) pp. 740–2.

Agglutinins and other anti-bodies were demonstrated, and complement fixation experiments were positive.

**Sero-Diagnosis of Plague by Means of Ascoli's Precipitation Method.***—H. Berlin has carried out a series of experiments with antigens prepared from plague-infested organs, the organ-pulp being mixed with 5 to 10 times its volume of normal salt solution, heated in the water-bath, and then filtered till quite clear. The agglutinating serum was employed in a dilution of 1 in 200. The precipitation tubes were incubated at 37° C., and examined for precipitation zoning after 5 and 30 minutes respectively. When the reaction was positive, a cloudy ring was formed at the junction of the antigen and the serum in the tubes. The antigen was present in the organs of animals dead with either natural or artificial infection, and the reaction occurred with both fresh and putrid organs; in the latter case, however, with less frequency. The intensity of the cloud-ring was found to be dependent on the amount of plague bacilli contained in the organ. The action is not specific: positive results were sometimes obtained with the controls containing extracts of the organs of normal healthy animals (rats and guinea-pigs). For this reason Ascoli's method cannot take the place of the ordinary means of bacteriological diagnosis of plague, and can only be regarded as a method of additional investigation.

**Pus-generating Diphtheroid Bacillus.**†—A. D. Pavlovsky has isolated the *Bacillus pyogenes albus diphtheroides* (first described by him in 1909) from twelve cases of suppurating gun-shot wounds met with on the Russian Front. In six cases the bacillus was in pure culture; in the remaining cases, mixed with staphylococci. The organism is usually located outside the pus-cells, is Gram-positive, and resembles a recently cultivated diphtheria bacillus. It grows on agar and on Loeffler's serum in from twenty to twenty-four hours, and does not liquefy gelatin. Guinea-pigs inoculated in the abdominal cavity with 1 c.cm. of broth culture die in about two days, positive cultures being recovered from the liver and spleen. Clinically, suppuration with formation of greyish or whitish-grey pus, fever (102° F.), and occurrence of fistulæ are present, but the infection is localized and the prognosis good. Pavlovsky considers that this bacillus should be added to the group of primary suppurative organisms.

* Centralbl. f. Bakt., 1te Abt. Orig., lxxv. (1915) pp. 467–85.
† Russkiy Vrach (Petrograd) xiv. (1915) pp. 721–3.

# MICROSCOPY.

## A. Instruments, Accessories, etc.*

### (1) Stands.

**Genevan Universal Microscope for Mineralogical Researches.**†—This type of Microscope (figs. 8, 9, 10) has been designed to afford a means of making on the same instrument observations the most diverse. At the same time the stand is of a very complete construction, and its adjustments so rigorous as to give an observer entire confidence in his results. The Microscope can be used with the system of permanent centring, or of optional centring. In the former case the objective becomes an adjunct of the stage, and in this form the instrument will adapt itself very conveniently to researches in polarized light on the constitution and properties of minerals. In the system of optional centring the objective becomes an adjunct of the tube, and the Microscope can be easily changed into this form from the other without the removal of even a single screw. In the optional form the instrument would be used for all researches requiring Fédorow's methods, as well as for those requiring long-frontal distances; for such classes of observations, its completely rotating stage, and the facility of adjusting the stage-level, render it particularly convenient.

When used with permanent centring (fig. 8), the objective becomes a part of the stage, and the Bertrand lens, V, is placed at the lower extremity of the tube by means of the forceps *p*. The objective is maintained by the usual pinch-grip on the slide-arm *c*, which itself is connected by the screw with the slide-block C. The milled head B controls the coarse-adjustments of the objective, and the fine-adjustments are performed by the screw *b* with its graduated drum. The construction of the arrangement for measuring thicknesses automatically overcomes all play of the screw, and the use of the double slide-block C,$c_1$ protects the micrometric screw from over-rapid use. The complete object-carrier can, by means of the knob *d* mounted on a large looped helix, be rapidly applied to the stage or removed therefrom.

* This subdivision contains (1) Stands; (2) Eye-pieces and Objectives; (3) Illuminating and other Apparatus; (4) Photomicrography; (5) Microscopical Optics and Manipulation; (6) Miscellaneous.

† Société Genèvoise pour la construction d'instruments de physique et de mécanique. Genève. Special pamphlet, 8 pp.

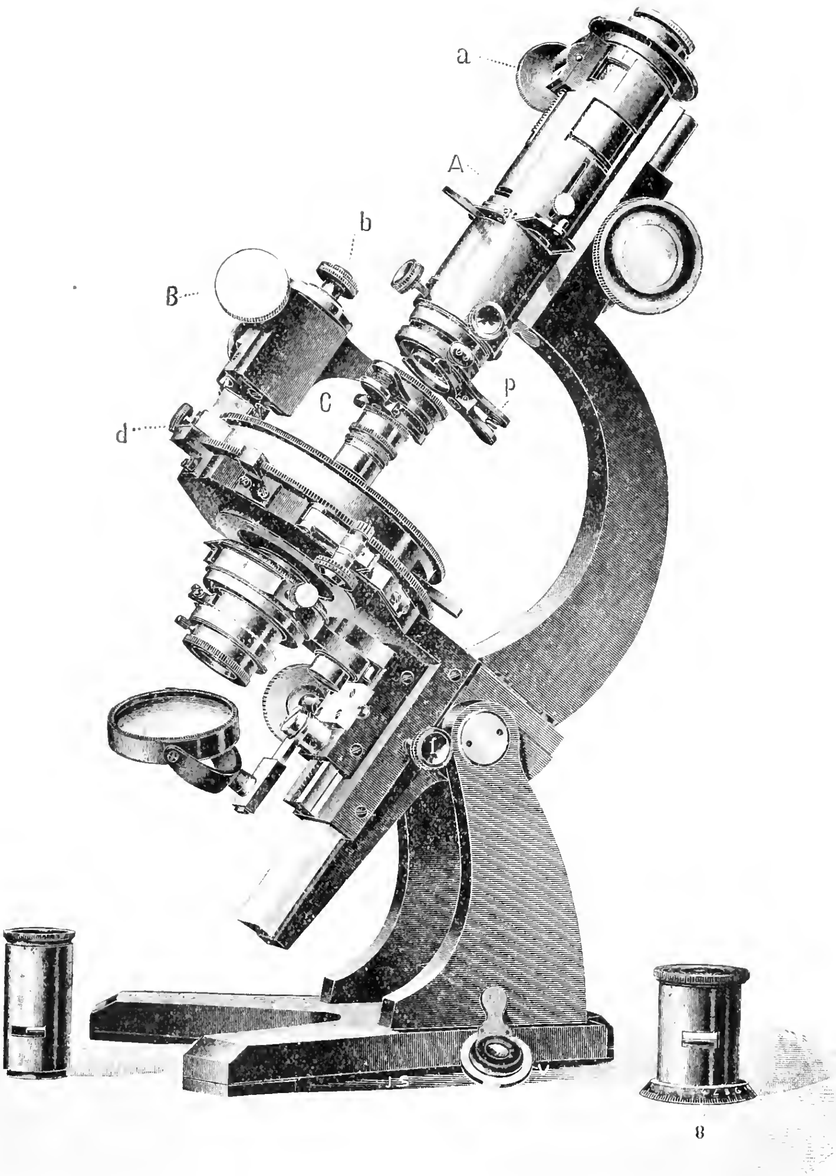



Fig. 8.

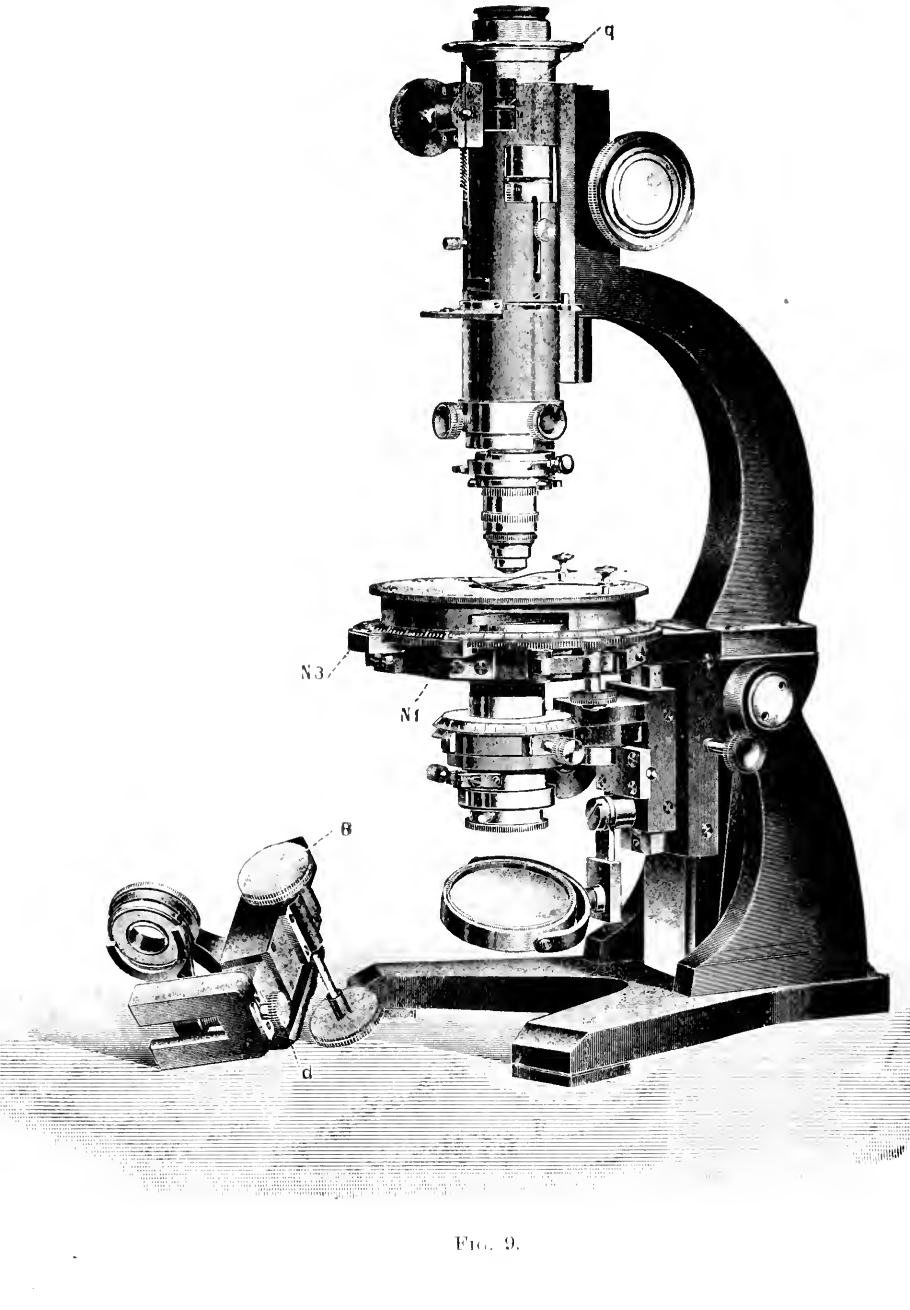



Fig. 9.

The object-carrier engages in a very exact gearing, which secures that the optical axis of the Microscope passes exactly through the rotation-centre of the stage.

When used for optional centring and for Fédorow's stage (fig. 9), the object-carrier is removed, and the objective is fixed by the pinch-grip $p$: the Bertrand lens B now passes to A. To fix the Fédorow stage the Microscope stage is brought to zero (Vernier $n_1$): the apparatus is placed so that the axis of rotation $y_1$ is perpendicular to the plane of symmetry, and the limb is on the right. By means of the fixation screws this axis can be set parallel to the corresponding thread of the network without the necessity of turning the stage of the Microscope. The rings and the central lens V are in the same plane. The height of the Microscope stage will be regulated by the consideration that the tube should be supported by its middle part. The polarizing and analyzing nicols are movable: the divisions 0 and 90°, on their graduations, correspond to the fundamental positions of the principal sections, crossed or parallel, according to the plane of symmetry of the Microscope or its perpendicular. The stage, mounted on a guide-block, can be raised or lowered for the use of long frontal distances, and is firmly and solidly fixed by help of the knob $l$. At the height of the focal plane of one of the negative oculars the tube is pierced with an opening $q$ at 45° of the plane of symmetry analagous to that which is situated above the clip $p$. This aperture can be screened if desired: a similar opening is pierced in the corresponding ocular. The displacements of the ocular apparatus, which is controlled by a rackwork $d$, can be read off on a graduation contrived on the tube. In the opening A a Bertrand lens can be inserted whose focus is independent of the position of the tube. The condenser can be removed if desired. The stage carries two verniers, $n_1$ and $n_2$, whose graduations are in the same sense, and whose zeros are distant by 1°5′, in addition to a mark $n_3$, whose index is at 45° from the zero of $n_1$. The adjustment is then finished, and the apparatus is ready for work.

The new model (fig. 10) of Fédorow's stage is constructed as follows: The axis $y_1$ is a part of the same metal piece as that forming the exterior disk $x$ which carries the vernier $m$. The rotations of the axis $y_1$ are measured on $j$, whose limit is doubly divided from 0 to 180°. A second ring $y_2$ graduated completely can turn on the disk $x$, and carries the trunnions of a second axis H, which is usually placed perpendicular to $y_1$, and which is served by the vernier $m$. The central disk $t$ can be sloped by rotation around H, and its inclinations measured either with the circular arcs W mounted on hinges on the ring $y_2$ perpendicularly to the axis H, or by sight on the borders of the disk $t$ and read off on the vernier $j$, after the axes H and $y_1$ have been brought into coincidence at the zero of the vernier $m$. The mount of the central glass V can be turned in the disk $t$, and its position is noted by the divisions of $t$. This lens bears a cross whose centre is at 0·15 mm. below the crossing-point of the axis $y_1$ and H. This point is also common to the rotation axes of the disks $y_1$ and $t$. When the adjustment is once finished the Microscope axis should also pass through this point.

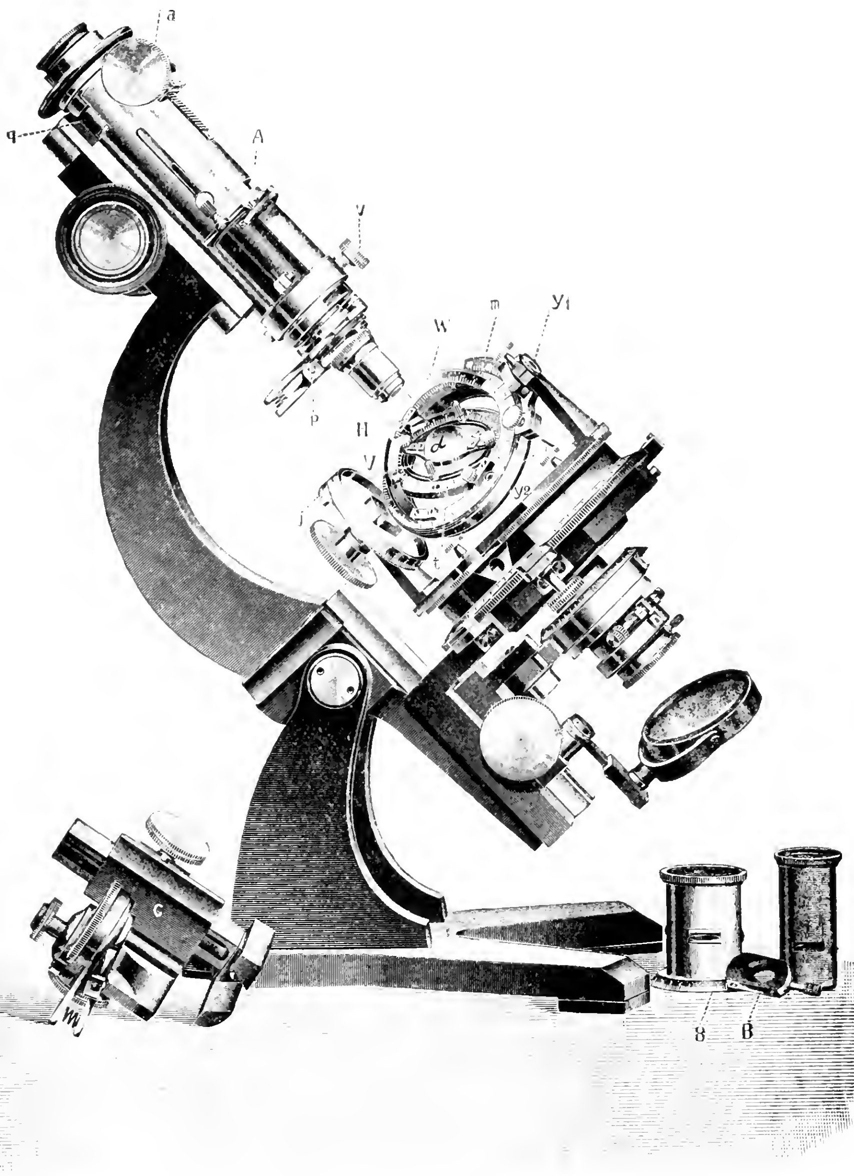



Fig. 19.

### (3) Illuminating and other Apparatus.

**Artificial Daylight for the Microscope.***—During the last two years H. P. Gage, working in the laboratories of the Corning Glass-works, has developed a glass filter which renders the light from a nitrogen-filled tungsten lamp almost exactly like daylight. An energy-diagram of the tungsten lamp shows very great divergences from that of the solar spectrum, especially in the green, yellow and red; but when the tungsten-lamp light is passed through the author's glass (Daylight glass, G. 172 cD) the curve approximates very closely to that for sunlight, especially between wave-lengths $0 \cdot 45\ \mu$ and $0 \cdot 65\ \mu$—i.e. in the region of the visible spectrum giving the greatest amount of useful light. The light filtered through the *daylight* glass has been very critically tested in the author's laboratory on microscopic objects stained with many different dyes, some of them even with several dyes on the same specimen. To make sure that the Microscope itself in no way modified the colour values apochromatic objectives and compensation oculars were used, as well as the achromatic objectives and Huyghenian oculars. The experiments were conducted near to a window so that comparison with actual daylight could be readily obtained. The author states that it was impossible to detect any difference between the artificial and the natural effects. In practice it was found desirable to have the *daylight* glass finished with the ground or velvet surface on one or both sides, and to place it in the opening of an opaque screen between the artificial light and the Microscope. With this arrangement of the light the effect is like that from a white cloud.

## B. Technique.†

### (1) Collecting Objects, including Culture Processes.

**Cultivation of Plasmodia of Badhamia utricularis.‡**—In continuation of previous notes § on artificial feeding of plasmodia of this species A. E. Hilton reports ‖ that plasmodia cultivated on bread and water, with the addition of a mixture of ammonium and calcium phosphates and cane sugar, formed spores in due course. A growth was started on Feb. 19th last year by reviving a fragment of sclerotium. For some weeks, owing to low temperatures, development was slow: but on the weather becoming warmer, it increased considerably; and on May 5th, when the atmosphere became close, with a thunderstorm impending, the plasmodia changed into a quantity of sporangia. There were, however, striking differences between these sporangia and those produced in natural conditions. They were similar in shape, but instead of being of the usual cinereous hue, they were mostly a dark purple

* Science, n.s. xlii. (1915) pp. 534–6 (1 fig.).

† This subdivision contains (1) Collecting Objects, including Culture Processes; (2) Preparing Objects; (3) Cutting, including Embedding and Microtomes; (4) Staining and Injecting; (5) Mounting, including slides, preservative fluids, etc.; (6) Miscellaneous.

‡ See also this Journal, 1915, p. 191.

§ Journ. Quekett Micr. Club, 1914, xii. 381.

‖ Journ. Quekett Micr. Club, 1915, p. 585.

black; others being of a cinnamon brown colour, and some of a pale biscuit tint. All were sprinkled with white cyrstalline particles. The sporangium walls, usually very thin and fragile, were hard, thick, and chippy. There was no distinguishable capillitium. Stranger still, the sporangia were only about half the ordinary diameter; in other words, about one-eighth of the usual size. The spores, generally bright brown and spinulose, were smooth and almost colourless; but were of the usual dimensions, if not, on the average, slightly larger; and in all other respects appeared to be perfectly normal. The characters on which the classification is based were thus altered in nearly every particular, the only permanent feature being apparently the specific spore-plasm. It was subsequently found that the spores germinated freely in the usual way; but the formation of plasmodia from the resulting swarmpores was not observed, further developments being prevented from an undue growth of fungus and large numbers of infusoria. In cultivating plasmodia on bread when the natural food, *Stereum hirsutum* or *Polyporus versicolor*, is not readily obtainable, the following mixture has proved very satisfactory: Cane sugar, $\frac{1}{4}$ oz.; ammonium phosphate, 60 grm.; calcium phosphate, 60 grm.; white starch, 30 grm.; dilute sulphuric acid, 10 drops; water, 1 pint.

**Artificial Cultivation of Hansen's Bacillus.***—H. Bayon, in answer to criticisms by Fraser and Fletcher with regard to the cultivation of *B. lepræ*, states in reference to transmissions to animals that "whether one injects ground-up nodules or Kedrowsky's culture, in the great majority of cases the bacteria get simply eliminated without leaving any visible trace. In single rare instances they produce bacillary deposits similar to those found in the inner organs of lepers." "We cannot expect skin lesions in animals inoculated with leprosy; all we can hope for are discrete deposits in the inner organs. If they can be transmitted through some generations and persist for a considerable time, and the bacillary deposit is superior to the quantity injected, then it seems to me that by all the laws of experimental medicine the inoculation has succeeded. This is the case with one experiment fully described in my paper."

He further maintains that "it cannot be too often repeated that the scanty positive results obtained in the experimental study of leprosy are absolutely in keeping with what we know of the clinical features of the disease, its low and eminently capricious infectivity; but that here more than when dealing with any other disease, the partial and incomplete interpretation of hundreds of negative observations cannot invalidate the proof positive of a single successful inoculation."

### (5) Mounting, including Slides, Preservative Fluids, etc.

**Venetian Turpentine Method: a Substitute for the Glycerin and Glycerin-jelly Methods.**†—C. J. Chamberlain remarks that the great practical advantages of the method are that preparations are as hard and

* Ann. Trop. Med. and Parasit., ix. (1915) pp. 535-8.
† Journ. Micrology, 1916, pp. 8-12.

durable as balsam mounts, and that a much greater variety of staining is possible than in the case of glycerin mounts. After fixing and washing in water, the general outline of the method is as follows:—(1) 10 p.c. glycerin until concentrated. (2) Wash the glycerin out thoroughly in 95 p.c. alcohol. (3) Stain: use stains dissolved in about 90 p.c. alcohol. (4) Wash in 95 p.c. alcohol, and complete the dehydration in 100 p.c. alcohol. (5) 10 p.c. Venetian turpentine in an exsiccator until the turpentine becomes thick enough for mounting. (6) Mount in the Venetian turpentine.

While this is the general outline, it is not sufficiently definite for a working introduction. The following concrete examples, describing the use of Venetian turpentine with an aqueous stain, with an alcoholic stain, and with a combination of aqueous and alcoholic stains, will be more practical than general directions. The steps from fixing to mounting, as used with an aqueous stain, will be described first, since this will introduce the method in its least complicated form.

*Haidenhain's Iron-hæmatoxylin.*—Using *Spirogyra* as a type, proceed as follows:—(1) Fix 24 hours in chromo-acetic acid: 1 p.c. chromic-acid, 70 c.cm.; glacial acetic acid, 3 c.cm.; water, 90 c.cm. The volume of the fixing agent should be at least 100 times that of the material to be fixed. (2) Wash in water, 24 hours. (3) 2 p.c. aqueous solution of ammonia sulphate of iron, 2 hours. (4) Wash in running water, 20 minutes. If running water is not available, wash in a large quantity of water and change frequently. (5) Stain over night, or 24 hours, in ½ p.c. aqueous solution hæmatoxylin. (6) Wash in water, 20 minutes. (7) 2 p.c. aqueous solution of ammonia sulphate of iron, until the stain is satisfactory. This can be determined only by examining frequently under the Microscope. (8) Wash in water, 2 hours. If this washing is not thorough, the continued action of the iron-alum will cause the preparations to fade. (9) Transfer to 10 p.c. glycerin, and allow the glycerin to concentrate until it has the consistency of pure glycerin. It is not necessary to use an exsiccator. Merely put the glycerin into shallow dishes, and leave it exposed to the air, but protected from dust. If the material is in Petri dishes, or other dishes with a large surface, three or four days will be sufficient. This process should not be hastened by warming. (10) Wash out the glycerin with 95 p.c. alcohol. It will be necessary to change the alcohol several times. From 10 to 20 minutes will be sufficient if the alcohol is changed frequently. (11) Complete the dehydration in 100 p.c. alcohol: 10 minutes should be sufficient. (12) *Most failures are now ready to occur.*

From the absolute alcohol the material is transferred to a 10 p.c. solution of Venetian turpentine in absolute alcohol. The turpentine thickens as the alcohol evaporates, and when it reaches the consistency of pure glycerin the material is ready for mounting. *The 10 p.c. Venetian turpentine is very sensitive to moisture*, and most failures are due to this characteristic; consequently the concentration cannot be allowed to take place with the turpentine exposed to the air of the room. Use an exsiccator. This will not only absorb the moisture from the air, but will soon remove the alcohol from the turpentine mixture. Make

an exsiccator as follows: place a saucer full of soda lime (sodium hydroxide with lime) on a plate of glass, and cover with a bell-jar. This is a simple and effective exsiccator. Instead, you may simply scatter soda lime in the bottom of any low museum jar with tight-fitting cover. The saucer of soda lime may be placed on a smooth board and covered with a perfectly tight box. You may improvise other forms; the essential thing is to provide a small air-tight space in which the soda lime may work. Instead of soda lime you may use fused calcium chloride or the white sticks of sodium hydroxide. Paint the exsiccator black, or cover it with black paper, or in some other way shut out the light. Many stains are weakened by light.

We are now ready for the transfer from absolute alcohol to the 10 p.c. Venetian turpentine. *Make the transfer quickly.* Pour off the absolute alcohol and place the dish, with the material, in the exsiccator: then pour on the 10 p.c. turpentine, *and immediately put on the cover.* This is better than to pour on the turpentine and then try to get the dish well placed in the exsiccator. The greater the surface of soda lime exposed, the more rapid will be the concentration of the Venetian turpentine. The concentration must not be *too* rapid. Not less than two days should be allowed for the concentration of 30 c.cm. of the turpentine in an ordinary Minot watch-glass. Great care must be taken not to let any of the soda lime, or other drier, get into the turpentine. As soon as the turpentine has attained the consistency of pure glycerin, it may be exposed to the air without any danger from moisture; but the turpentine would soon become too thick for mounting. If the turpentine has become too thick, thin it with a few drops of absolute alcohol, or with 10 p.c. or any thin solution of Venetian turpentine.

Mount the material in a few drops of the Venetian turpentine, and add a cover. Square covers may be used, since it is entirely unnecessary to seal the mounts. Such mounts are as hard and durable as balsam mounts. Material in the thickened Venetian turpentine, if not needed for immediate mounting, may be put into small vials or shells, where, kept out of the light, it can be kept indefinitely. We recommend a No. 4 shell. The corks should be of the best quality, otherwise the turpentine will become too thick. While it can be thinned by adding thin turpentine, it is better, for easy mounting, not to let the turpentine become too thick.

*Magdala Red and Anilin Blue.*—Fix in chromo-acetic acid and wash in water, as described in the previous schedule. Transfer from water to 10 p.c. glycerin and allow the glycerin to concentrate. It is not necessary to use an exsiccator, since there is no danger from moisture in the air. When the glycerin attains the consistency of pure glycerin, wash the glycerin out with 95 p.c. alcohol and then proceed with the staining. (1) Stain in Magdala red. At least two Magdala reds are sold by dealers. The one marked *echt* is more expensive, but, in our experience, is inferior to the one marked simply Magdala red. Make a 1 p.c. solution in 90 p.c. alcohol. We use the stain much stronger than recommended by Pfeiffer and Wellheim. This solution, diluted with an equal volume of 95 p.c. alcohol and allowed to act for 24 hours, does not stain too deeply. (2) Rinse the material for a minute in 90 p.c.

alcohol. (3) Stain in anilin blue, using a 1 p.c. solution in 90 p.c. alcohol. diluted with four times its volume of 90 p.c. alcohol. We prefer to make a fresh solution every time we have anything to stain. It is not necessary to measure it. A little of the powder—about half the bulk of a grain of wheat—in 30 c.cm. of 90 p.c. alcohol, will give an efficient solution. The time required for successful staining will vary from 3 to 30 minutes. Do not put all the material into the anilin blue at once, but, by trying a few filaments at a time, find out what the probable periods may be. (4) Rinse off the stain in 90 p.c. alcohol, and then treat for a few seconds in acid alcohol (1 very small drop of HCl to 30 c.cm. of 90 p.c. alcohol). The acid alcohol fixes and brightens the anilin blue, but extracts the Magdala red. If the anilin blue or the acid alcohol acts for too short a time the blue will be weak: if they act too long, the red is lost entirely. If the blue overstains too much, wash it out in 95 p.c. alcohol. If the red overstains, wait until the mount is finished, and then reduce the red by exposing the slide to direct sunlight. (5) Absolute alcohol, 5 or 6 seconds. (6) Transfer *quickly* to 10 p.c. Venetian turpentine and proceed as in the previous schedule.

The surprising beauty of successful preparations will compensate for whatever failures may occur. Nuclei and pyrenoids should show a brilliant red, while the chromatophores and cytoplasm should be dark blue. The cell walls should show a faint bluish color.

*Haidenhain's Iron-Alum Hæmatoxylin and Eosin.*—Follow the schedule for iron-hæmatoxylin until the glycerin has been washed out in 95 p.c. alcohol. Then stain for a minute in a solution of eosin in 95 p.c. alcohol. Wash for a minute in 95 p.c. alcohol, then a minute in absolute alcohol, and then transfer to the 10 p.c. Venetian turpentine. Other stains may be used. Aqueous stains should be used before starting with the 10 p.c. glycerin. Alcoholic stains should be in strong alcohol—about 90 p.c.—and should be applied just after washing out the glycerin. This method is equally good for filamentous fungi and also for the prothallia of *Equisetum* and ferns, for delicate liverworts and mosses, and similar objects.

### (6) Miscellaneous.

**Concentration of Malaria Plasmodia.***—C. C. Bass and F. M. Johns have devised a method of concentrating malaria parasites, the fundamental principle involved being that the malaria plasmodium with its host erythrocyte is larger than the non-parasitized blood-cell, and that when centrifuged at the proper speed for a sufficient length of time, the larger cells rise to the top of the cell column, while the smaller cells collect beneath. The leucocytes, being still larger, rise to the surface of the tube.

Measure 0·2 cm. of citrate-dextrose solution (50 grm. sodium citrate and 50 grm. dextrose in sufficient distilled water to make a volume of 100 c.cm.) into a large tube. Draw 10 c.cm. of blood

* Amer. Journ. Trop. Diseases and Prevent. Med. iii. (1915) pp. 298–303.

with a syringe from the patient's vein and add, at once, to the citrate solution in the tube. Mix by revolving or shaking the tube. The blood may be examined at once or at any time during the following twenty-four hours. The dextrose seems to preserve the cells and plasmodia against changes, and could just as well be omitted if examination was always made within an hour or two after the blood was drawn. Place equal quantities of the citrate-dextrose blood in two large centrifuge tubes—the depth of the column may vary from 2–5 c.cm. The length of time for centrifugalization depends upon the length of the arm and the speed of the centrifuge. In the authors' case the distance from the centre of the centrifuge to the bottom of the tube was 18 c.cm., necessitating a speed of 2500 revolutions per minute. The mixture should be centrifuged one minute for each cm. of the column of blood to be centrifuged. All the plasmodia (except the small æstivo-autumnal rings) and the leucocytes, rise to the top of the cell-sediment and are in the first 0·1 cm. With a large pipette skim off as much as possible of this layer from each tube and place in one (or two) 0 5 cm. tubes Take up at the same time as much plasma as cells, and after placing in the small tube mix thoroughly by drawing back and forth into the pipette. The column in the small tube must not be deeper than 5 c.cm. Centrifuge as before. Now, with a large capillary, draw not more than a 5 c.cm. column of the cells into it from the surface of the cell-column. It is a good idea to mix this by forcing it in and out of the pipette against the surface of a slide. Draw it up into the pipette past the tip and seal the end of the pipette in a flame. Cut off part of the capillary containing the blood and centrifuge as before. After centrifuging, there will be found a small amount of greyish leucocyte mass merging into the column of red cells. In very heavy infections the lower part of the leucocyte layer and the upper part of the erythrocyte column have a brownish appearance from the pigment present in the large amount of plasmodia here. Cut the capillary at a point 0·1–0·2 cm. below the bottom of the leucocyte layer, and with a smaller capillary draw out the small amount of erythrocytes and leucocytes and a little plasma to dilute them with. Mix and make one or more blood-spreads of the usual kind. Stain and examine in the usual manner.

**Histological Basis of the different Shank Colours in the Domestic Fowl.***—H. R. Barrows fixed the material in 10 p.c. formalin. Free-hand sections were made and mounted in glycerin. Many fixatives and stains were tried, the best being formalin hæmatoxylin, eosin and Sudan iii. The following summary of the results is given: 1. Yellow and variations are due to the presence of lipochrome pigment in the epidermis with the absence of melanin pigment. 2. White results from the lack of pigment. 3. Blue colour obtains when melanin pigment lies in the upper dermis, with the absence of this type of pigment in the epidermis. 4. Black and variations depend upon the presence of melanin pigment in the epidermis. 5. Green appears when lipochrome pigment lies in the epidermis and melanin pigment in the

* Rep. Maine Agric. Exper. Stat., 1914, pp. 237–52 (12 figs.).

corium only. All shades with the exception of red and pink are the result of various combinations of these pigments; orange-yellow and black-brown.

**Differentiation of the Eberth-Coli Group by means of Collodion Reagent Papers.***—A. Ch. Hollande and J. Beauverie state that the members of this group of organisms can be differentiated by means of four test papers prepared as follows :—1. Nitrate of silver paper. Filter paper (e.g. Schleicher and Schüll) is soaked in 1 p.c. nitrate of silver solution and is then dried rapidly between two sheets of blotting-paper—after drying, the paper is plunged into a mixture of alcohol and ether containing 10 p.c. of pure collodion. The paper is then removed and rapidly dried. 2. Glucose-neutral-red paper. The filter paper in this case is plunged into a solution containing glucose 2·5 grm. in 25 c.cm. of 1 p.c. aqueous solution of neutral red. This paper is dried and coated with collodion as above. 3. Acetate of lead paper. 10 p.c. aqueous solution of acetate of lead is here employed, the rest of the technique being as before. The paper, which is white in colour, should be kept in a stoppered bottle. 4. Litmus-orcine-lactose paper. The solution in which the filter paper is immersed is prepared as follows :—Litmus-orcine 20 grm., neutral phosphate of sodium 4 grm., lactose 5 grm., bicarbonate of sodium 1 grm., distilled water 50 c.cm.

A portion of each of the four test papers is dropped into different tubes containing 6 c.cm. of broth and then sterilized in the autoclave. When cool the tubes are inoculated with the suspected organism and incubated at 37° C.

*Bacillus typhosus* alone, after twenty-four hours, does not decolorize the broth containing glucose-neutral-red paper, moreover the paper remains at the bottom of the tube, and is not brought to the surface by gas bubbles as with *B. coli* and the paratyphoid organisms. *B. paratyphosus A* does not blacken the acetate of lead paper, as do the other organisms. *B. paratyphosus B* alone possesses the property of restoring the lilac colour to the medium containing litmus-orcine-lactose, after three days; the other organisms permanently discolorize the medium. *B. coli* alone gives a growth in the nitrate of silver medium, ten or twelve hours after inoculation.

By employing a paper made with a mixture of acetate of lead and glucose neutral red the organism can be determined as follows :—With *B. typhosus* the liquid remains red and the paper is blackened; with *B. paratyphosus A* the liquid is slightly reduced but the paper remains red: with *B. paratyphosus B* and *B. coli* the red colour completely disappears and the paper is blackened. The red colour is replaced by a yellowish fluorescence.

* C.R. Soc. Biol. Paris, lxxviii. (1915) pp. 722–5.

## Metallography, etc.

**Microchemistry of Corrosion.***—C. H. Desch and H. Hyman have applied the electrolytic methods previously described to two alloys (gun-metals) containing copper, tin and zinc in the approximate proportions 88 : 10 : 2 and 84 : 14 : 2. Each alloy was tested as cast, and also after a heat treatment which altered its constitution. It was found that the amount of corrosion was more affected by small variations of the conditions, especially of the applied electro-motive force and of the state of the surface, than in the case of the brasses. The preliminary removal of the flowed surface layer produced by polishing, by etching with acid ferric chloride solution, eliminated one cause of discordant results, and was more readily attacked than the eutectoid, which was not affected unless the voltage exceeded a certain critical figure. Corrosion was less than that of the brasses under similar conditions.

**Copper-zinc-tin Alloys.**†—O. F. Hudson and R. M. Jones have studied the constitution of brasses containing small percentages of tin. Fifty-two alloys containing 0·3 to 5 p.c. tin and 43 to 69 p.c. copper, the remainder being zinc, were microscopically examined. Nearly all the alloys were annealed below 450° C. for periods of 18 hours to 15 days to obtain equilibrium. Some thermal curves were taken. The polished specimens were etched by means of a polish-attack with ammonia. The constituents found were $\alpha$, $\beta^1$, and $\delta$. $\alpha$ appeared reddish-yellow, $\beta^1$ bright yellow, and $\delta$ clear light blue. In a number of the alloys all three constituents were present in equilibrium. A diagram is given representing the equilibrium constitution for ordinary temperatures of the ternary alloys containing 50 to 70 p.c. copper and 0 to 5 p.c. tin; the solubility of tin in brasses and the limits of composition within which the alloys consist of three phases $\alpha$, $\beta^1$ and $\delta$ in equilibrium, are defined.

* Journ. Inst. Metals, xiv. (1915, 2) pp. 189-98 (6 figs.).
† Journ. Inst. Metals, xiv. (1915, 2) pp. 98-115 (17 figs.).

# PROCEEDINGS OF THE SOCIETY.

## AN ORDINARY MEETING

OF THE SOCIETY WAS HELD AT No. 20 HANOVER SQUARE, LONDON ON WEDNESDAY, FEBRUARY 16TH, 1916, MR. E. HERON-ALLEN, PRESIDENT, IN THE CHAIR.

**The Minutes** of the last Meeting, which had been circulated, were approved, and duly signed by the President.

**The Hon. Secretary** read the names of the following candidates for election, whose certificates were suspended in the usual way:—Messrs. C. H. Bocock, P. J. Hazledine, and John Richardson.

**Dr. Eyre** showed a Portable Incubator, made by Messrs. Hearson and Co., for use in bacteriological work. It consisted of a small oak box, having a compartment surrounded by resistance wires, and heated by a 4-volt accumulator at one side, and furnished with a switch to enable the current to be turned on or off. The compartment was large enough to accommodate a small metal tray or cage, to carry test-tubes of nutrient media. A small clinical thermometer, suspended by a couple of stays on the inside of the door, recorded the temperature.

Before reading the paper by himself and Mr. Charles Rousselet, on "The Progress and Development of Vision and Definition under the Microscope," the **President** said it devolved upon him to thank Mr. Earland for assistance given in preparing the material, and also Mr. Court for the immense amount of labour that he had devoted to the matter, and the readiness with which he had placed at the disposal of the Society his unparalleled knowledge of ancient Microscopes. He had given several days to the preparation of the exhibit, with the manual assistance of an expert sent by Mr. C. Lees Curties, who had been good enough to have the instruments in the collection cleaned up and arranged for this occasion.

The text of the paper itself will appear in due course in the pages of the Society's Journal.

**Mr. Court** stated that it had been generally thought that the aquatic Microscope was an improvement on Ellis's Microscope, and at first sight

it seemed to be so; but it had to be remembered that John Ellis only used low powers for his special work, and those low powers had to be used on organisms in fluids, and the instrument had to be placed in an erect position. Ellis made suggestions to Cuff, who made a Microscope, now known as the Ellis Aquatic Microscope, first figured and described in 1755. In "An Essay towards a Natural History of the Corallines" (1755), Ellis says: "In August 1752 I went to the Island of Sheppey on the Coast of Kent, taking with me a very commodious Microscope of Mr. Cuff's, the Optician in Fleet Street, which I had altered for that purpose." Mr. Court considered this to have been the type from which Ellis's Aquatic Microscope was developed, and in this opinion Mr. Nelson agreed. Later he had come across an original advertisement by Cuff, in which he advertized this Microscope as an aquatic Microscope. In 1758 it was further improved by the addition of a compound body, and in other small details: the original descriptive pamphlet of this newer model was entitled, "The description of a single and double microscope very convenient to observe all sorts of objects. London, printed by R. Pardon in Castle Yard, Holborn: 1758." Dollond also made the Ellis Aquatic Microscope about 1765, and in the printed description calls it the aquatic Microscope as improved by John Ellis, F.R.S.

**Mr. Earland** then drew attention to the points of interest in the various Microscopes which had been removed from the Society's collection in order to illustrate the paper, commencing with the little Leeuwenhoek, which was a model of the original, presented by Sir Frank Crisp. Leeuwenhoek, he said, no doubt saw most remarkable things through the lenses which he made for himself from little spheres of glass, but the definition of the reproduction was very poor. In the Lieberkuhn model there was really excellent definition. It was a troublesome model to adjust, as there was no means of locking the specimen when focused. But once focused and properly adjusted for light, remarkable definition was obtained, and, except for the small size of the image, it was as sharp and clear as with a present-day lens. There was, in his opinion, no improvement in the definition of the image from this point onwards until the reflecting type of instrument was reached. Some of the models fell below the general average as regards sharpness of definition. The first real improvement was found with the introduction of the substage condenser, and when the reflecting Microscopes were reached there was an absence of colour, and a consequent increase in the definition of the image; an improvement which was increased by the fact that about the time the achromatic lens was invented balsam-mounting came in. There was no comparison between the image given by such a combination and any of its predecessors.

In conclusion, he would like to add to what the President said in regard to the indebtedness of the Society to Mr. Court. Owing to the regrettable illness of Mr. Rousselet the bulk of the preparation for the demonstration had fallen on Mr. Court, and but for him there could have been no exhibition, because even to manipulate and set up these old types would have been beyond the powers of the speaker or any other microscopist who was not deeply skilled in the lore of the antique Microscope.

**Dr. Charles Singer** was particularly interested in the President's suggestion that Conrad Gener had figured a magnified image of a Foraminifer as early as 1565. The reference was quite new to the speaker, and must be by far the earliest of the kind yet unearthed. It was extraordinary that though convex spectacles, often of considerable power, were in use from about the year 1300, they seem never to have been used in investigating minute Nature. Yet want of interest in natural phenomena can hardly be charged against such men as Leonardo da Vinci, Albrecht Durer or Bernard Palisez!

He also drew attention to Manzini's book ("L' occhiale all' occhio, Dioptrica pratica"), of 1660, placed on the table by the President, which which was one of the few early works dealing with the manufacture of lenses, a process which was to a large extent a trade secret. The work was valuable as revealing the methods of Enstachio Divini, one of the first great microscope-makers. Lenses in the early part of the 17th century were a very costly luxury. As much as the equivalent of £50 would sometimes be paid for a good pair of spectacles. Martin's double-adjustment Microscope was mentioned as being the first of its kind, and stress laid on the importance of a substage condenser in the production of a clear image. A Microscope, however, was figured by Zahn (1685) and by Bonani (1709) as having belonged to Athanasius Kircher (1601–1680). This instrument was probably in use before 1658 and had both a coarse- and a fine-adjustment, as well as an apparatus corresponding to a substage condenser. A substage condenser also formed part of the curious Microscope figured by Descartes in his "Dioptrique" as early as 1637, which figure was the first yet discovered of an actual compound instrument; though Galileo already in 1610, and Kepler in 1611, published diagrams of the path of light in such an instrument. Dr. Singer was glad to hear that the Royal Microscopical Society was considering the preparation of a History of Microscopes and Microscopy. Such a work was greatly needed.

**Mr. Ainslie** regarded this as one of the most striking exhibitions, both of mounts and Microscopes, that he had ever seen or heard of, and he wished to be allowed to congratulate the Royal Microscopical Society thereon. He commented on the fact that very little was said in the paper about the advent of the substage condenser. The Foraminifera were all shown under low powers, and for such the substage condenser would not be a very striking improvement. But it was due chiefly to the substage condenser that the Microscope has shown such marked improvement. Non-achromatic objectives might have been made of large aperture, and used with monochromatic light —as had been done in the Zeiss quartz objectives, for use with ultra-violet light—but as Dr. Dallinger said, "without a condenser a Microscope is merely a magnifying-glass; with one, even if it is only a hemispherical lens in a stage-plate, it becomes a scientific instrument." He had also hoped to have heard something about the improvement of the image due to the employment of a larger cone of illumination than could be obtained from a concave mirror. He was interested in the big Powell Microscope, and would ask if the objective shown on the stand was an "inch," and of the same date as the stand. John Marshall's

"new invented double Microscope" was a wonderful piece of apparatus, and he wondered how the illumination was managed. In the illustration in "Carpenter," a candle was placed close under the condensing lens, which would be either blacked or cracked, or both, in a short time.

**Mr. Gabb**, in referring to the question of the advent of the substage condenser, pointed out that it was in the John Marshall Microscope on exhibition, and which dated from about 1690—a scientific instrument of wonderfully good performance for its time.

**Mr. Court** considered that some of the early objectives by Powell, especially the lower powers, dating as far back as 1841, were practically as good as those in use to-day, apochromatics excepted. The reflectors for the reflecting Microscopes were constructed after the form of the Newtonian telescope; there was a small aperture above the stage, and the light from the object on the stage was reflected by a plane mirror, fixed at an angle of 45°, upon a concave elliptic speculum fixed at the further end, which was again reflected towards the eyepiece. The only means of changing the power in this form of Amici's Microscope was to change the power of the eyepiece; several eyepieces of varying power were supplied with that instrument. John Cuthbert, who made the smaller reflecting Microscope, was especially celebrated for the short focus, and the accuracy with which he ground the mirrors of his reflecting telescopes; these instruments were produced under the direction of Dr. Goring.

**Mr. Blood** was convinced from the pattern of the mount that the Powell objective was later than the stand, but could confirm what had been said, that some of the lenses of about that date were of great excellence. He endorsed what had been said already about the extreme interest of that exhibit. He remarked upon the overpowering influence of the chromatic aberration compared with the spherical aberration in the better of these images, and inquired whether any devices were used to get rid of the chromatic aberration, as, for instance, monochromatic light, either by coloured glasses, or coloured solutions, or the sodium flame. On looking at the images among the uncorrected Microscopes, he noted how very soon the limit of useful magnifications was reached, and when the power was higher the aberrations very soon become quite distressing.

**Mr. J. E. Barnard** then demonstrated by means of the ultra-Microscope:—

(1) The manner in which sulphur emerges from solution. In explaining the experiment, Mr. Barnard reminded the Fellows that if dilute sulphuric acid was added to a dilute solution of hyposulphite of soda, a deposition of sulphur results. Theoretically it was assumed that the sulphur at once began to separate out, but was at first in a highly divided state, possibly molecular particles size; these then aggregated in increasing volume until they became visible sulphur particles. He could not accept this theory, because if correct a luminous light cone would be apparent where the substances are not in complete solution before the particles became visible; in cases where

substances occur either as aggregates or in the colloidal state, a light cone was visible, even if particles were not. When the solution referred to was examined under the ultra-Microscope, nothing was to be seen for some minutes, and then particles of sulphur became visible, which increased in number and size until there was a brilliantly illuminated cone of sulphur particles scintillating in the beam. It appears probable, therefore, that there was a latent period between the mixing of the solutions and the appearance of the sulphur particles.

(2) He then discussed the artificial bleaching of green fluorite by ultra-violet rays. Pure white fluorite was very difficult to obtain; still more so pure white fluorite transparent to the extreme ultra-violet. A green variety of fluorite, however, was plentiful, and by exposing this to ultra-violet light, such as that from the quartz mercury vapour lamp, it was possible to bleach it perfectly in a very short time, and so obtain white fluorite. On passing a beam of light through fluorite, he demonstrated a beautiful violet-blue Tindall cone with the ultra-Microscope. This cone arose from the ultra-violet light, which was transmitted and changed in wave-length. There was a narrow band of ultra-violet between the extreme end of the visible violet and the limit of transmission of glass. By illuminating fluorite with an ordinary beam, through a screen consisting of a solution of sulphate of quinine (itself transparent and colourless), the whole of the ultra-violet was cut out, and the violet light cone disappeared. The ultra-Microscope showed no differentiation of structure between pieces of fluorite naturally colourless and others bleached by exposure to ultra-violet light, and it seemed reasonable to anticipate that fluorite bleached by ultra-violet light would be as useful for making apochromatic objectives as natural white fluorite.

---

**The Secretary** gave notice of the subjects which had so far been arranged for discussion at the Meetings during the Session, and the Meeting terminated.

## AN ORDINARY MEETING

OF THE SOCIETY WAS HELD AT 20 HANOVER SQUARE, LONDON, ON WEDNESDAY, MARCH 15TH, 1916, MR. E. HERON-ALLEN, F.L.S. F.G.S., ETC., PRESIDENT, IN THE CHAIR.

**The Minutes** of the last Meeting, having been already circulated, were approved, and duly signed by the President.

---

The following three gentlemen were balloted for as Ordinary Fellows of the Society, and were declared by the President to be duly elected:—Charles Hanslope Bocock, Frederick James Hazledine, John Richardson.

**The Hon. Secretary** read the Nomination papers of the following Candidates:—Frederick Ashworth, Professor Benjamin Moore, F.R.S., Sydney Pitt, Francis E. Robotham, Dr. Charles Singer.

---

**Donation**—

| | From |
|---|---|
| Mount for Artificial Daylight Disc .. .. .. .. .. .. | *Mr. C. Lees Curties.* |

---

**Dr. Eyre** exhibited two Warm-Stages (Electric) for the Microscope.

1. Lorrain Smith's Warm-Stage consisted of a flat glass chamber, filled with liquid paraffin and mounted in a wooden frame. Inside the chamber were two manganin-wire coils, connected to screw terminals on the framework. By interposing a resistance and an ameter, one could regulate the current applied to the heating coils, and thereby adjust the temperature of the liquid paraffin to practically any temperature from 25° C. up to 100° C.

2. The Electric Warm-Stage of the Chicago Surgical and Electrical Company, a very simple and practical piece of apparatus, found very useful by those who were engaged in hunting for the amœbæ of dysentery. It consisted of a rectangular metal frame, which contained resistance (heating) wires within its walls, and was provided with a make-and-break contact regulated by a small screw. The apparatus carried a clinical thermometer, and the necessary extra resistance was provided by a 16-candle power lamp. The slide, with the material to be examined already mounted, was dropped into the cell to form the bottom, and the stage was placed on the stage of the Microscope; the top of the cell was covered in with a mica plate, in which was a circular hole to admit the objective. Once the apparatus had been regulated to

the required temperature, the cavity which was enclosed between the glass slide and the mica plate would remain constant without further attention.

**Mr. Scourfield** exhibited a living specimen of a Copepod, *Belisarius viguieri* (found in the water collected in the cups formed by the bases of the leaves of Bromeliaceous plants at the Royal Botanic Gardens), to show the peculiar pulsating organ associated with the maxillary gland. When first described (by Maupas) it was thought to be of the same nature as the vibrating organs or "flame-cells" of Rotifers. It was, however, a muscular action, the apparatus probably acting as a pumping-organ in connexion with the maxillary gland, as had recently been described by Chappuis. So far as he (Mr. Scourfield) was aware, this organ was unique among the Crustacea. There was, however, a pulsating organ in the Cladoceran, *Leptodora*, shown in his second exhibit, as far as the structure could be demonstrated in a preserved specimen. It occurred at the distal end of the first joint of the first pair of feet, and it was worked by a little cross muscle. The organ was probably useful in connexion with the circulation. Gerschler (1910) suggested that there was possibly some stagnation of the circulation in the first pair of legs, which were very long, which the pulsating organ helped to remove.

**Sir Ray Lankester** said he had observed with great interest the vibrating organ of *Belisarius*, and, if possible, he would like to see very fine sections through the region concerned, in order to make sure that it was really muscular.

**Mr. Scourfield** replied that he showed specimens of *Belisarius* to Dr. Warren in 1903—which was long before the paper to which he had referred was published—and Dr. Warren made sections, which he, the speaker, had also examined. He did not know where they were now, probably with Dr. Warren in South Africa. The examination of the sections confirmed what was made out when looking at the living animal.

**Professor J. Arthur Thomson, M.A., LL.D.** (Past President), then delivered his paper on "Originative Factors in Evolution," which will appear *in extenso* in the Journal.

**Sir Ray Lankester** voiced the appreciation of all present when he characterized the address as one of the best he had ever heard on that difficult and profound subject of variation and heredity, presented in a delightful and charming way. He referred to one point which Professor Thomson did not touch, viz. that there was just as much difficulty in supposing permanent stability as incessant variation. There *must* be variation: everything was flowing, moving, changing, and the aim of the biologist was to determine the precise channels of variation.

**Professor Arthur Dendy** agreed with Sir Ray Lankester that it was marvellous that the organism should have powers of so regulating the constitution of its germ plasm that variation was largely avoided.

**The President** said it remained for him to propose a vote of thanks to Professor J. Arthur Thomson, who had come all the way from Aberdeen to give the Society this address, and he was happy to endorse from the chair every word of appreciation uttered by Sir Ray Lankester.

The vote was carried by acclamation.

---

**Sir Ray Lankester, K.C.B., M.A., D.Sc., F.R.S.,** prefaced his paper on "The Supposed Exhibition of Purpose and Intelligence by the Foraminifera" by expressing his pleasure in welcoming Mr. Heron-Allen as President of the Society, and assuring his audience that his criticism of some of the views put forward by the President implied no want of regard or affection for his friend.

This paper and the President's reply will appear in full in the Journal.

**Professor Flinders Petrie** ventured a word or two with regard to the desperate poverty of language which was one of the main points that the paper made. There were plenty of cases—he believed well authenticated—in which men had got up in their sleep and written out statements of which they were totally unconscious, but which had solved questions on which they had been deliberating for some time without being able to reach a solution. He assumed that there was purpose and intention in that writing, but it was absolutely unconscious purpose and intention.

**Professor Benjamin Moore** said that looking at evolution as a whole, one found continuity all through it. Most people, unless they were heretical as he was, believed there was a breach between the inorganic world and the organic. The physicist and chemist were now beginning to recognize some continuity between the electron and the inorganic colloid. There was a point in evolution at which only two or three molecules were united together in which it passed the wit of man to say whether one was dealing with a crystalloid or a colloid. So if one desired to get away from pure matters of terminology, one must bear in mind that continuity. One found wonderful cleverness in the insect, such as in the one which knew exactly where to stick its sting into the caterpillar a determined number of times so as to paralyze but not to kill its victim; and that looked much like purposive intelligence. There might be a very complex mechanism for carrying out a small purpose, which was very clever within the limits of that purpose, and yet was not comparable to the work of the human brain. Much of the talk as to the difference between instinct and intelligence existed because of loss of perspective. Deeper thinking led one to ask, "Is there anything purposive?" We believed we had purposes, but those things were laid down in us, either by heredity or by previous training. While there seemed in the human case to be a choice, it was not clear that there was, any more than in the case of the Foraminifera. The choice, so far as it existed at all, seemed to him—though it might seem a peculiar opinion for a scientist to hold—to lie in something outside, playing in upon us and guiding

our progress which we ought to try to hold on to, but which seemed to be sadly forgotten by certain people and nations.

**Dr. J. R. Leeson** said it must be realized that this question in dispute was largely a question of the meaning of words. To him the meaning of "purpose" was "acts adapted to ends," and on that view one must admit that the Foraminifera were undoubtedly adapting their various functions and activities to definite ends.

**Professor J. Arthur Thomson** said when he left Aberdeen there was much snow; some of the roads were blocked, and he saw the wind making beautiful snow wreaths. He asked himself whether there was any purposefulness in the wind's finely finished work, and he answered emphatically, No, because he felt he could interpret it all, without introducing any concept of purpose, purely by means of the laws of dynamics. Then he asked himself whether, in coming south, he had himself any purpose, whether his behaviour in making the journey was purposeful or purposive; and, with all deference to Professor Moore, he felt compelled to answer in the affirmative. The difficulty in the present discussion seemed to lie, then, between those two extremes, between the work of the wind and the higher reaches of man's work. When rooks took freshwater mussels up in their claws and let them fall on the shingle with the result that the shells were broken and the flesh made available, that also was probably intelligent purposefulness.

He believed that man's behaviour, when it was on a high level, illustrated *conceptual purposefulness*, while that of the rook alluded to illustrated *perceptual purposefulness*. The starfish often did battle with the sea-urchin; it wrenched off with its tube-feet the snapping blades which are called pedicellariæ. And having done that with one sector, it proceeded to the next, until it had wrenched off all the weapons. The starfish could not be following the line of least resistance in so doing; it required time and energy, and perhaps discomfort, to disarm the sea-urchin in that way. And it must be remembered that the starfish had not a single ganglion or nerve centre. Yet there was prolonged behaviour directed towards an end which was not immediate; it was prolonged activity directed towards a future result. He called that *organized purposiveness*, and it was, he believed, in the same category as the activity of the President's Foraminifera. His suggestion was that they should recognize a long inclined plane—conceptual purposefulness, perceptual purposefulness, instinctive purposiveness and organized purposiveness. What would be the criterion of purpose? He would say that purposefulness, or, it might be, purposiveness, was exhibited when an organism showed a capacity for summarizing past experiences in such a manner that an endeavour was engendered which dominated behaviour towards a result not immediately attained. But the measure of awareness or pre-awareness, as Professor Lloyd Morgan called it, which attended this endeavour must remain largely a matter of opinion.

**Professor Arthur Dendy, Messrs. Bullamore and Blood** continued the discussion.

**The President** then dealt at some length with Sir Edwin Ray Lankester's criticisms.

**Sir Ray Lankester**, in replying, said his paper was based simply on the desire to maintain the correct use of words. Most people agreed that the English language should be applied in accordance with its common usage; it was not justifiable to select a term and give to it a meaning which was intended to be suggestive or poetical. His objection was to the deliberate attribution by Mr. Heron-Allen of "intelligence" to the Foraminifera. During the evening's discussion several speakers had used the word "purpose" in a sense which was not the ordinarily accepted one. Professor Thomson, however, was careful in his remarks to place before the word when he used it a number of adjectives, such as "conceptual," "perceptual," "organismal," or "organized." When used with such a qualifying adjective the word "purpose" became more or less metaphorical. It was quite safe to use the word "purpose" in the sense of the definition given in the Oxford Dictionary.

The President had alluded to certain views, and described the response of Foraminifera to stimulation. He, the speaker, proposed to account for those actions as due to a mechanism established by natural selection.

**The President** proposed a cordial vote of thanks to Sir Ray Lankester for his very interesting paper.

This was carried by acclamation.

# JOURNAL

OF THE

# ROYAL MICROSCOPICAL SOCIETY.

JUNE, 1916.


## TRANSACTIONS OF THE SOCIETY.

### IX.—*A case of Apparent Intelligence exhibited by a Marine Tube-building Worm, Terebella conchilega.*


By Arnold T. Watson, F.L.S.


(*Read May* 17, 1916.)

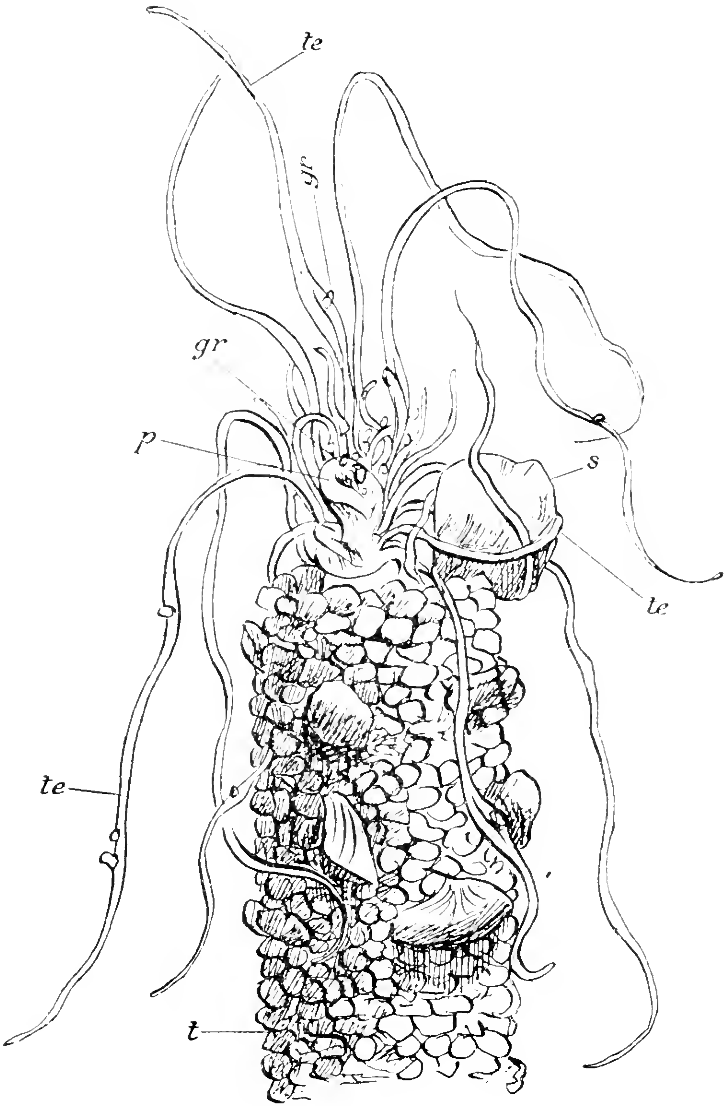
Figs. 11, 12.

The building habits of this worm were described by me many years ago in the Journal of this Society.*

The incident to which this Note relates occurred some time later, and as it may be of value, bearing upon the question of the existence or otherwise of "purposive intelligence" in the lower animals, I now place it on record.

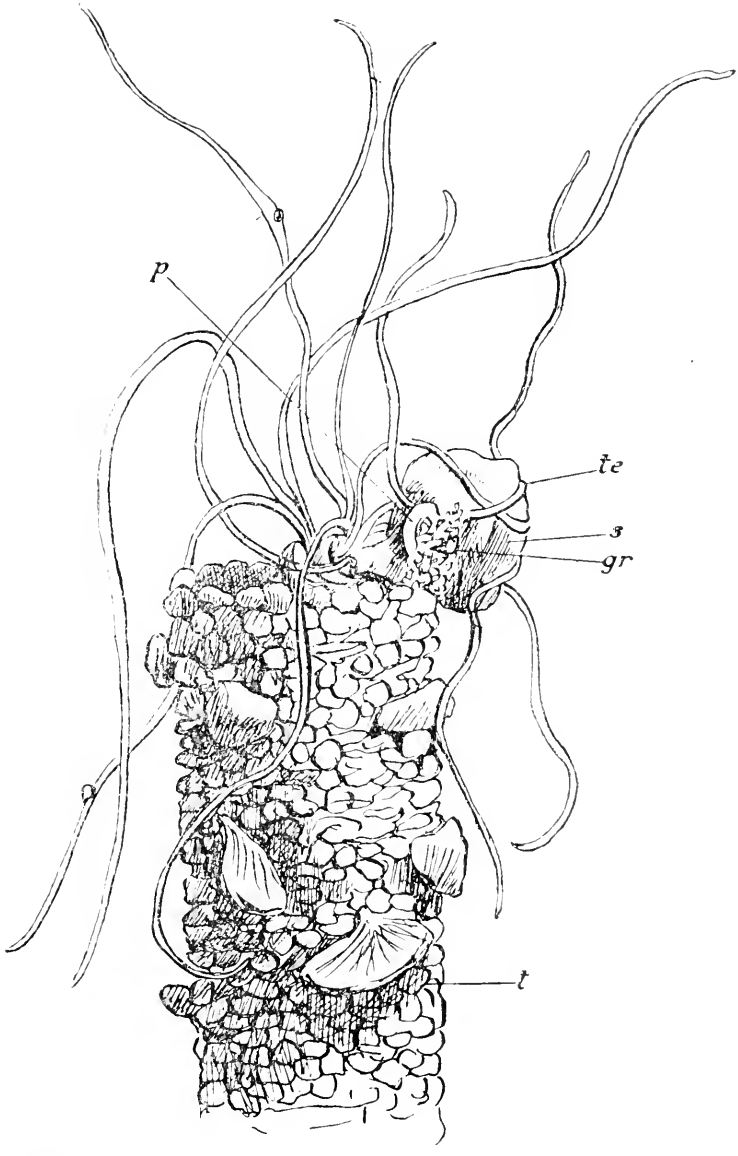
Whilst watching, one evening, through the Microscope, a small specimen carrying on its building operations, I noticed that, with the combined effort of several tentacles, the worm was lifting to the rim of its tube a bit of gravel too large to enter the opening, and I remarked to a friend present in my room on the folly of the operation, for it seemed to me the stone was too large to be used for food, and that when placed on the edge of the tube it must necessarily fall off, as the cement supplied by the animal's lips would be too weak to hold it in position. I was wrong! The worm was quite equal to the occasion! The stone in due time reached the edge of the tube, held by several tentacles; the worm then emerged to receive it, and with its lips grasped as much of the stone as they would cover, and then rested it upon the edge of the

* See this Journal, 1890, p. 685.




A. W. del.

Fig. 11.—Sketch of living *Terebella* in tube (*t*) temporarily supporting with its tentacles (*te*) the large stone (*s*) prior to fixing it permanently on the rim with the sand-grains (*gr*), which are being poured into the up-lifted lips or prostomium (*p*) by the smaller tentacles.




*A. W. del.*

Fig. 12.—Sketch showing the worm supporting the stone (*s*) by placing the sand (*gr*), received and cemented by its lips (*p*), underneath the right-hand side.

tube. Now I expected to see it fall, but this was prevented, for the worm still supported it by the tentacles passed around. The empty lips were meanwhile held up as though asking for something; a supply of small grains of sand was brought up by the long outer tentacles and emptied into the lips by the smaller ones (a state of affairs which is illustrated by fig. 11); then the head or forepart of the worm stretched out of its tube sufficiently to enable the lips to empty their contents, mingled with cement, outside and just underneath the stone, as illustrated in fig. 12; the tentacles still retained their hold; the lips were held up and a second time filled with sand; this second supply of supporting material was, as before, placed underneath, *but on the opposite side of the stone*; then the tentacles relaxed their hold, the stone having been scientifically supported and securely fixed in position, with all the skill of a professional builder.

The operation on the part of the worm was quite deliberate, and my observations were reported to my friend, bit by bit, as the events occurred, and I see no possibility of error.

The drawings which accompany this Note were made at the time in order to record what appeared to me to be a display of intelligence such as I had not previously seen, and such as I have never seen since. Whether the facts observed should be attributed to instinct, or reason, or can be explained in the more modern way as response to an external stimulus, I will not venture to decide.

## X.—*Studies in Marine Biology.*

By F. Martin Duncan, F.R.P.S.

*Read April* 19, 1916.

Figs. 13, 14, 15.

It was my intention to-night to have given some account of my experiences in photographing, collecting, and preserving marine biological specimens, but, as the hour is late, I will curtail my remarks, and give a brief description of some of the photographs exhibited on the screens and tables, and of some of the apparatus used in obtaining them. The prints represent a small selection from the very large collection of negatives which I have made during the course of a good many years devoted to marine biological studies, and I should like to say that a large number of them could not have been obtained but for the existence of the Marine Biological Association of the United Kingdom, an institution deserving the support of all microscopists who are in any way interested in the teeming forms of microscopic life to be found in the sea.

I should like to draw your attention to this photomicrograph of the *Puerulus* stage of *Palinurus vulgaris*, the Crawfish, or Langouste as it is called in France. It is of interest as the first photomicrograph to be taken of the original specimen, discovered by Monsieur E.-L. Bouvier, during his stay at the Marine Biological Association's laboratory at Plymouth during the summer of 1913. I happened to be carrying out some work in the Laboratory at the time, and Monsieur Bouvier very kindly permitted me to take the photomicrograph for him, and has used it to illustrate his paper on the development of *Palinurus*, published in the Journal of the Marine Biological Association.*

I should like also to draw your attention to the set of prints showing some of the phases in the segmentation of the eggs of *Echinus esculentus*, and which are printed from parts of a micro-kinetograph negative obtained with a special form of apparatus I have designed for taking kinetograph records of living microscopic forms of life. In obtaining this interesting series of pictures I was greatly assisted by my friend Dr. Creswell Shearer, of Cambridge,

* Journ. Mar. Biol. Assoc., x. No. 2, p. 179.

who has devoted much attention to the artificial fertilization of the eggs of *Echinus*.

The photomicrographs of marine parasitic Protozoa I need not describe, as explanatory titles are attached, and I think the same may be said to apply to most of the other photographs exhibited to-night: therefore I may pass at once to some brief description of how they were obtained.

I began taking my first photographs of marine animals and their anatomy at the time that my dear father, the late Dr. P. Martin Duncan, occupied the Presidential chair of this Society, and these early attempts were undertaken with a view to relieving him

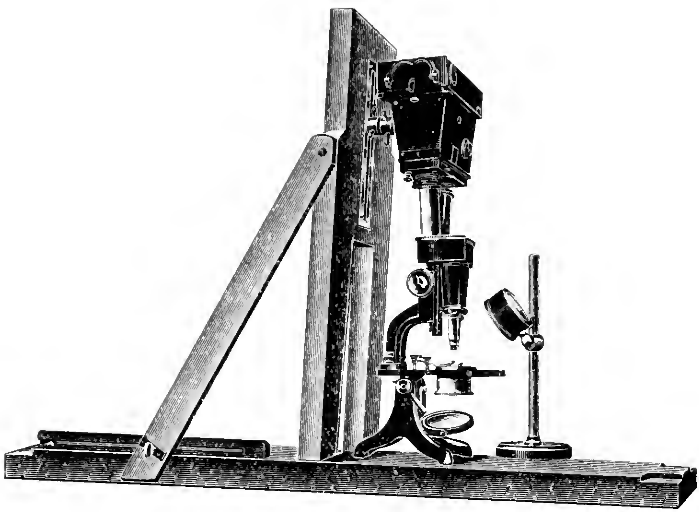


Fig. 13.—Stereo-binocular Microscope and Verascope Camera in position for taking Stereoscopic Photomicrographs.

from some of the long hours of eye-strain in the course of his microscopic investigations into the anatomy of the Corals and Echinoderms. Those first studies were obtained with the aid of an old wet-plate camera and collodion wet-plates of home manufacture, which gave me a very useful insight into the chemistry of photography. I have found that for practically all marine biological work either an isochromatic or a panchromatic plate must be used to obtain the best results, and most truthful rendering into monochrome of the various colour-values of the subject. Subsequent enlargement of part or the whole of the negative often being necessary, it is most important to select a plate of fine grain. Most of the direct prints and enlargements exhibited to-night

have been made on the Ortho A, B, or C plates manufactured by M. M. Lumière, and the very fine chromatic and panchromatic plates of the Ilford Company. For obtaining natural colour photographs of the subjects, I consider that the beautiful Lumière autochrome plate is the only direct colour-plate that will faithfully render the object with all its true tints. For all photomicrographic work backed isochromatic or panchromatic plates should be used.

In photographing the larger forms of marine animals, either in the rock-pools or in the special tanks, a good Reflex camera,

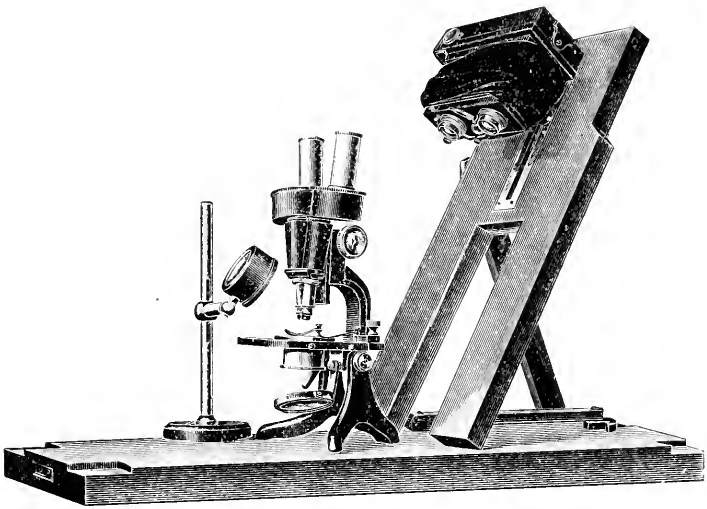


Fig. 14.—Showing the upright support for the Verascope Camera drawn back, leaving the Eye-pieces of the Stereo-binocular Microscope free for focusing the specimen.

such as the Newman and Guardia model, which I have now used for many years, will be found invaluable, as enabling one to watch and keep the animal in focus up to the moment of exposing the plate. Sky reflections are often a great trouble when working in the rock-pools, and I have found a light metal cone, that can be attached either to the front of the camera, or to a stand, so that one end is beneath the surface of the water—practically a water-telescope—a simple and certain way of avoiding surface reflections. One of the great difficulties one has to contend with is the sensitiveness of all marine creatures to change of temperature, a rise of only a few degrees being quite enough to produce very marked effects, particularly with many plankton forms, Hydroids, etc.

It is, therefore, most important to keep the water in observation or photographic aquaria at a constant temperature, and is best accomplished by inlet and outlet syphons, so that a gentle circulation is always taking place. By this means the creatures are kept in a healthy condition, and their movements and appearance normal. The photomicrographs of living Hydroids have been obtained in this way, using a zoophyte trough mounted on a special stage, and with a low-power objective attached to the Reflex camera. When a higher magnification is necessary, I use one of Messrs. Charles Baker's R.M.S. Microscopes, which I consider one of the most perfect instruments for biological research, and in conjuction I either use the Reflex camera, or a Leitz demonstration eye-piece and the ordinary photomicrographic camera.

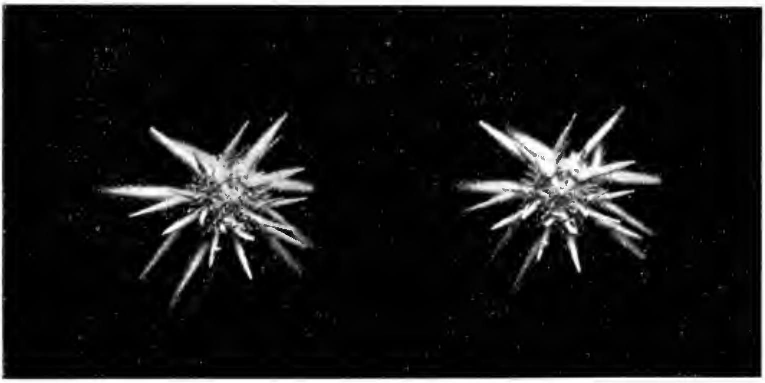


Fig. 15.—Stereoscopic Photomicrograph of Young Echinus, taken with the Stereo-binocular Microscope and Camera as shown in figs. 13 and 14.

In studying such forms of marine life as the Polyzoa, true stereoscopic photomicrographs are of very great assistance, and by the method I employ are comparatively easily obtained. I used Baker's model of the Greenough Stereo-binocular Microscope. This is placed on a baseboard, which has an upright to carry the stereoscopic camera—a $7 \times 13$ c.cm. Verascope of fixed focus. The object on the stage is focused through the eye-pieces of the Microscope, and the camera is then gently lowered into position, so that the lens almost touches the front lenses of the Microscope eye-pieces, and the plate is exposed (fig. 13). As the lenses of the camera are set at infinity, there is no need for further focusing, if the eyes of the observer are normal and he has in the first instance obtained a critically sharp image through the

Microscope. I do not claim any originality for this method of working, for my attention was first drawn to it by a veteran microscopist, the late Dr. F. Bossey, who told me he had employed it many years ago, I think in the early "sixties," with a box-form wet-plate camera and a monocular Microscope. As a simple and quick way of producing photomicrographs of low and medium magnification, and with the Stereo-binocular Microscope, it will be found very useful.

# XI.—*Alien Oligochæts in England.*

By The Rev. Hilderic Friend.

(*Read May* 17, 1916)

Figs. 16-20.

## *Dichogaster lageniformis* sp. n.

In a communication which I had the honour to submit to the Royal Microscopical Society in January last (*6*)*, some details were given of a new species of exotic Oligochæt (*Kerria rubra* Friend) which was found by me in the Botanic Garden at Oxford. The present paper deals with a second species of worm found in the same locality and at the same time. The description is based upon a series of longitudinal sections through the first 22 segments of an adult worm. Unfortunately, the specimen was found to contain a good deal of earthy matter which materially affected some of the sections, especially in the region of the gizzard. All the essential organs are, however, present in perfect condition, and it is possible to prepare such a diagnosis as will leave no important element out of calculation.

The great difficulty has been to fix the exact position which

* The figures within brackets refer to the Bibliography at the end of the paper.

EXPLANATION OF FIGURES.

The numerals refer to the number of the segment.

Fig. 16.—Longitudinal section through segments 9-21, showing position of gizzard, intestine, œsophageal glands, prostates, and sexual organs.
,, 17.—Seta and sac from segment 3.
,, 18.—Spermathecæ, with diverticulum and muscular layer of body-wall.
,, 19.—Longitudinal section through anterior portion of worm (segments 1–8), showing prostomium, tongue, buccal cavity, salivary glands, pharynx, and pharyngeal gland.
,, 20.—Diagram of segments 1-21, to illustrate the relative position of the organs.

Abbreviations.—*b.c.* buccal cavity; *br.* brain; *b.v.* blood-vessel; *c.d.* common duct; *cut.* cuticle; *d.* diverticulum; *d.v.* dorsal vessel; *gir.* girdle; *giz.* gizzard; *f.* funnel; *f.p.* female pore ♀; *int.* intestine; *int.e.* intestinal enlargement; *mus.* muscle; *m.p.* male pore ♂; *n.* nerve; *neph.* nephridium; *œs.* œsophagus; *œs.gl.* œsophageal gland; *o.f.* funnel of oviduct; *ov.* ovary; *per.* peritoneum; *ph.* pharynx; *ph.gl.* pharyngeal gland; *pr.* prostate; *pros.* prostomium; *s.sac.* sperm-sac; *s.g.* salivary gland; *sp.* spermatheca; *spz.* spermatozoa; *t.* testis; *v.v.* ventral vessel.

the species occupies. The problem is to ascertain the genus to which it belongs, and though I have placed it for the present among the *Dichogasters*, that is only because the more important characters approach those of *Dichogaster* more nearly than any genus whose diagnosis I have been able to study. By the well-known process of elimination, it was possible without difficulty to decide that the worm must belong to the extensive family of Megascolecidæ. There are four pairs of simple pointed sigmoid setæ in each segment. The girdle extends over segments 13 to 20, the male pore is on segment 18, and the prostates open on the two adjoining segments 17 and 19. The female pore is on segment 14, there are two pairs of spermathecæ in 7/8 and 8/9, testes and funnels in 10 and 11, and ovaries in 13, while the gizzard extends from the 7th to the 10th segment. All these are characters of the Megascolecidæ (*10*).

But this superfamily is divided into nearly half-a-score of sub-families. The œsophageal glands are too far back for the sub-family Ocnerodrilinæ, the spermathecæ too advanced for Eudrilinæ, the nephridia rule out Diplocardiinæ and Acanthodrilinæ, and other characters make it impossible to relate the worm to the Octochætinæ and the Megascolecinæ. We are thus driven to the sub-family Trigastrinæ, and the genus *Dichogaster*; but even then the differences between the species now under discussion and the typical *Dichogaster* are considerable.

Following the method adopted in the paper to which I have already alluded, I propose to deal with the subject under the headings—Historical Survey, Distribution, Description, Relative Position, and Bibliography.

## I.—Historical Survey.

The genus *Dichogaster* was created by Beddard (*1*) in 1888, in a very valuable paper on the "Structure of *Urochæta* and *Dichogaster*." Early investigators had depended almost entirely on dissection, and as a result the smaller forms of Annelids were far from being fully and accurately described. Beddard employed the method of sectionizing, and was able in consequence to extend and perfect the earlier descriptions. In the case of the new type, *Dichogaster damonis* Bedd., one worm was dissected, and the other studied by means of transverse sections. The main points in the original diagnosis are the following:—The setæ, which are wanting ventrally in segments 17, 18, and 19, are paired and occupy the ventral side of the body; the girdle extends from the 13th to the 20th segments inclusive, and is more fully developed dorsally than ventrally. Dorsal pores present. A single pair of spermathecæ in segment 8; two gizzards, separated by a very minute œso-

phageal portion, each occupy two segments, 7–8 and 9–10. Behind the gizzards, in segments 15, 16, 17, are calciferous glands, the hindmost pair smaller than the two anterior pairs, and divided into distinct lobes. Testes in 10 and 11, with vesiculæ seminalis, and funnels. Ovaries in 13 large and conspicuous with oviducts. Each spermatheca divided into two parts—a sac or ampulla, and a mulberry-like diverticulum. Length about 100 mm., from the island of Fiji.

Later, Beddard (2) defined the genus, which had in the meantime been studied and extended by Michaelsen, thus:—

"Genus *Dichogaster* Beddard. Setæ paired. Dorsal pores present. Clitellum XIII–XX (XXIII). Male pores on XVII. Two gizzards; three pairs of calciferous glands. Nephridia diffuse. Spermiducal glands tubular."

The difficulty in defining the genus was admitted, and with Michaelsen's new species *mimus* and *hupferi* it was hard to say how it could be distinguished from the allied genus *Microdrilus*. In 1886 Benham (3) founded the genus *Trigaster* for a worm found in the West Indies (*T. lankesteri*), and later (*4*) in 1890 defined the genus (which had meanwhile received a new addition in Michaelsen's *T. rosea*) as follows:—

"Genus *Trigaster* Benham, 1886 ( = *Benhamia* Michaelsen, 1889). Setæ in close couples, all on the ventral surface, individual setæ of each couple close together. Clitellum occupies Somites XIV to XL; complete ventrally only on the first few somites. Spermiducal pores in XVIII, and prostate pores in XVII and XIX. . . . Prostates as in Acanthodrilus. No penial setæ. No dorsal pores are present. Spermathecæ simple pear-shaped sacs without appendices. . . . Three gizzards in Somites VII, VIII and IX. No calciferous glands. Anterior masses of nephridial tubules in Somites IV, V, VI grouped to form peptonephridia."

In his Monograph of the Order Oligochæta (2) Beddard separates the two genera *Dichogaster* and *Trigaster* by a great distance, but places *Trigaster* in close proximity to *Benhamia*. Indeed, the two genera show many points of divergence. Yet Michaelsen (*10*) in his volume on "The Oligochæta" makes the two genera into a sub-family which he names Trigastrinæ. One might question the propriety of this, but that is a matter of opinion. The sub-family is distinguished by the following marks:—Setæ 8 per segment, girdle extending over 4 to 27 segments, and beginning on or near segment 14. Male pores on 18, 17 or 19, prostate pores on 17–19. One or two pairs of spermathecæ opening in 7/8, 8/9. Two or three muscular gizzards in advance of the male organs, and three pairs of calciferous glands usually present at the posterior end of the œsophagus.

The main distinction between *Trigaster* and *Dichogaster* is said to lie in the latter relation. *Trigaster* has no calciferous glands

behind the ovary, while in *Dichogaster* there are usually three pairs of these organs present.

Since Beddard founded the genus *Dichogaster* it has been greatly extended, Michaelsen, so long ago as 1900, enumerating no fewer than 67 species. His definition of the genus so extended is as follows:—

"Setæ in pairs on the ventral side. Prostate pores 1–3 pairs on 17–19 segments. Spermathecæ 1 or 2 pairs opening in 7/8, 8/9. Two gizzards anterior to the male organs; sometimes only 2 pairs, but usually 3 pairs of calciferous glands behind the segment which carries the ovary, usually in segments 15–17, in rare cases beginning one segment earlier. So far as known two pairs of testes and funnels." A good deal is to be desired in this definition, and doubtless as our knowledge of this large and complex group of worms increases things will assume a more satisfactory form.

## II.—Distribution.

The first species of *Dichogaster* to be described was received by Beddard from Figi (*D. damonis*). In 1891 Michaelsen described a second species (*D. mimus*) from Accra, West Africa (*9*); and a third species the same year (*8*) from the same country. In 1900 (*10*) he summarized the known distribution in the following words:—"Tropical Africa (from Abyssinia to Mozambique on the one side, and from Portuguese West Africa to the Congo on the other), Antilles, America (from California to Guatemala and Dutch Guayana), Polynesia, Hawaii, Isle of Sunda, South Asia. Certainly endemic in Tropical Africa, and probably so for the Antilles and Central America. Some species have been introduced into various lands, including Upper Guinea, Madagascar, the Antilles, California, Mexico, Venezuela, Paraguay, Argentina, Germany and the East Indies." We have no means of knowing the original home of the species now under review.

## III.—Description of *Dichogaster lageniformis* sp. n.

As stated in my former paper, two years ago, while on a visit to Oxford I found in the Lily House at the Botanical Garden a species of worm which I had not previously seen. It was very tender, and perished before I could reach home. In June, 1915, I was able to pay another visit to the Garden, when I found *Kerria rubra*, *Dichogaster lageniformis*, and another worm which still awaits description. It is upon longitudinal sections of these worms that our present study is based.

*External Characters.*—*Dichogaster lageniformis* is a small slender and delicate worm, extending when in motion to about

1½ inches (35–40 mm.), but contracting to about half that length and to a breadth of 1 mm. in the widest part when preserved in alcohol. It is similar in appearance to *Kerria rubra* when living, but shorter and smaller. The head is "zygolobisch," and forms a strong upper lip. There is no head-pore, nor could I find any trace of other pores in the dorsal region of the body. The girdle

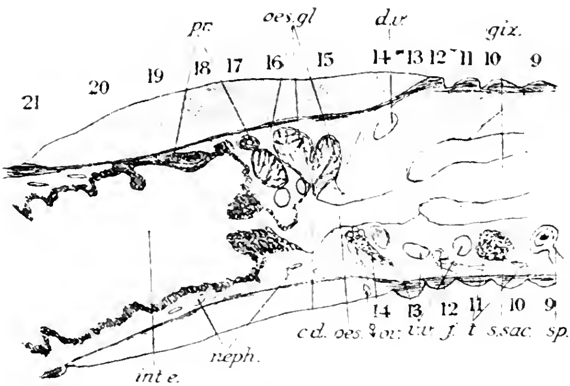



Fig. 16.

extends from the 13th to the 20th or 21st segment inclusive, and is very much developed dorsally (fig. 16). In front of the girdle there could be seen in the living worm a greenish stripe or longitudinal band internally. This is the gizzard. In the preserved

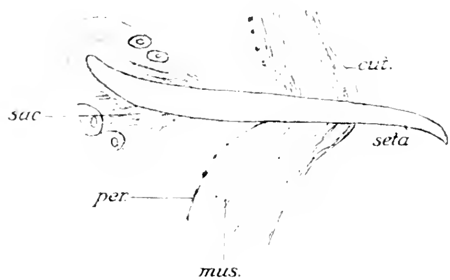



Fig. 17.

worm the intersegmental grooves are very deep, except in the case of the first three or four. The worm emits a good deal of turbid white matter when placed in alcohol. In this respect it reminds one of our British mucous worm (*Eisenia rosea* Sav.). The setæ are eight per segment, sigmoid (fig. 17) in four pairs on the ventral surface. I can find no evidence of ornamented or

penial setæ, neither do the setæ near the male or female apertures seem to be lacking as in *D. damonis*.

*Negative Characters.*—In my former paper it was observed that a fuller account of the negative peculiarities of new worms would often be of great service in diagnosis. The following points have been observed in the present species. There is an absence of pores on the dorsal region so far as the longitudinal sections extend, i.e. from the head to the posterior girdle-segment. Nephridia seem to be lacking until segment 12/13. There are no thickened septa, no penial setæ, no cœlomic corpuscles, and there seems to be an entire absence of penial bulbs and prostate papillæ. The only swollen portion which I have been able to detect is related to the female pore on the ventral surface of segment 14.

*Internal Characters.*—The internal structure has been most carefully studied by means of a complete series of longitudinal sections extending from the prostomium to the girdle inclusive. As already intimated, some of the sections are torn, owing to the presence of grit in the intestine. In many sections also the septa are either wanting or so congested that it takes a considerable time before one can be quite positive in certain cases to which segment a given organ is to be referred. By dint of frequent drawing and repeated revision, however, all difficulties have been overcome or reduced to unimportance.

The sexual organs, because of their importance, demand our first attention. The most advanced of these organs are the spermathecæ. Of these there are two pairs (as in *Kerria rubra*) opening in the inter-segments 7/8 and 8/9. They may be best described perhaps as hour-glass or bottle-gourd shaped, and this peculiarity has suggested the trivial name.* They are not attached to the œsophagus, but lie free in the cœlom; the foremost pair being smaller than the posterior. What may be regarded as a degenerate diverticulum is found on the anterior face of each spermathecæ. The spermatozoa, which I found here very sparsely, were in the early stage of development, while those present in the duct and ampulla were flagellate (fig. 18). In the duct there seemed to be distinct evidence that the spermatozoa were held together by a gelatinous cement. Although aliens in England, these worms were evidently quite at home. They cannot, I am told, have been imported in very recent years, but must have bred in the house for a long time, and the duct and ampulla were crowded with spermatozoa, showing that there had been intercourse between the individuals.

The testes are as usual situated in segments 10 and 11, where also may be seen the funnels, staining deeply on account of the

* *Lageniformis*, or having the shape of a flagon, hour-glass, or bottle-gourd. From the word lagena, λάγηνος, a flagon, the term *Lagenaria* has been derived. This is the generic name of the plants bearing bottle-gourds.

masses of spermatozoa. The ovary is in the normal position on the posterior side of the septum 12/13, while the funnel is on the anterior of 13/14, the duct opening anteriorly in segment 14. There is only one pore in this case. There are two prostates in 17 and 19, the opening of the male duct lying in the intermediate section. Only in the case of the oviduct do I find any distinct papilla, and there are no penial bulbs or protuberances in the specimen under review. The prostates are of uniform size throughout, and do not end in a muscular portion, as is sometimes the case.

The glandular system is rich and extensive. It includes salivary, pharyngeal and œsophageal or calciferous glands, each of

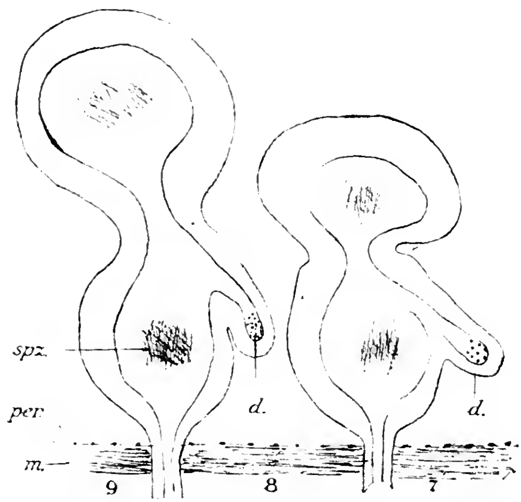



Fig. 18.

which merits attention. Beginning at the head we first discover a pair of glands, one dorsal and the other ventral, extending through segments 3 to 6 or thereabouts. They are not attached to the œsophagus, but to the peritoneum, and constitute the glands *à mucosité*, peptonephridia, or salivary glands of different authors. Benham (*4*) figures them as occurring in segments 1–3 only in typical *Dichogaster*. They possess no funnels, and are somewhat more dense or compact than is the case with similar organs in the Enchytræids, as shown, for example, in *Henlea fragilis* Friend (*5*). They coil round the posterior region of the pharyngeal gland, but are in no way attached thereto. The pharyngeal gland is seen to be closely associated with the pharynx, from which it is distin-

guished by the free manner in which it stains. There are no ducts from the gland to the pharynx, nor is the gland divided up, as is the case with the septal glands found in many other worms in this region of the body. In *Kerria rubra* Friend (*6*) the septa in this region are thickened to carry the glands, but in *Dichogaster lageniformis* there is no such thickening, and the septa give no indication of any close relationship with the glandular mass. At the same time one naturally assumes that the pharyngeal gland of *Dichogaster* is homologous with the septal glands of *Kerria* and other worms belonging to this family.

The œsophageal or calciferous glands are found in segments 15–17, which is the normal position for this genus, and constitutes perhaps the chief argument for regarding the new worm as a true *Dichogaster*. I use the alternative terms, because, while the glands are in part of the true œsophageal type, composed of alternate rods and open spaces, in part they are also solid and

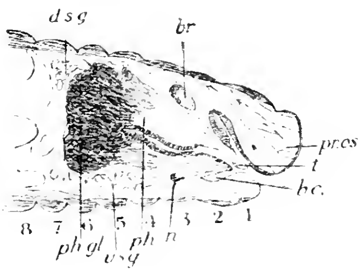



FIG. 19.

have all the appearance of calciferous glands. A reference to Benham's diagrams (*4*) shows that *Dichogaster* was the only genus then known which had three pairs of glands in this position. The hindmost gland is the largest, while the two anterior glands open by a common duct (fig. 16) into the œsophagus. I give a drawing of a section showing this interesting peculiarity. The structure of the main portion of the gland exactly corresponds with that of *Henlea fragilis* (*5*).

If, now, we turn to the digestive and alimentary region, we find some further features of interest. The tongue or taste-organ (fig. 19) is well developed. The pharynx is very simple in structure, and together with the pharyngeal gland extends back to the end of segment 6. In the 7th segment the gizzard commences. This organ has a constriction about midway, but owing to its torn condition, through being filled with grit when sectionized, its exact shape cannot be determined. It extends to the septum 10/11, but this is pushed back to the beginning of the girdle in

section 13, so that the gizzard appears to extend through six segments (7–12), as shown in the illustration (fig. 20). On the posterior portion of the œsophagus the calciferous glands occur, and immediately behind these, in segment 18, or possibly 19, the wide intestine opens out, lined with a very moderate typhlosole. The segments behind the girdle have not been studied.

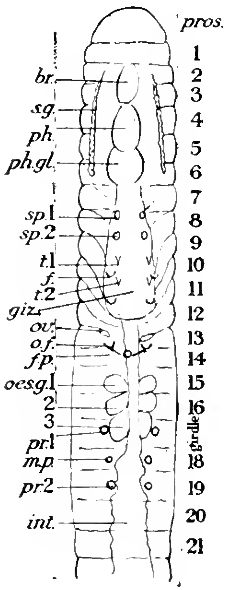


Fig. 20.

The nervous system is normal. One observes that the nerve-cord narrows at each intersegment, and this fact is often of great assistance in determining the number of a given segment when the septum is wanting, or is pushed out of position by the crowding of the organs.

The nephridia are of the microscopic type, and seem to commence in segment 12/13. I have been unable to discover their pores or funnels, and they are in every way different from the corresponding organs in the Enchytræids, which I have studied most fully.

The vascular system seems to differ from the type. I find the blood-vessels very large in segments 12, 13, 14, but there are lesser "hearts" in 15 and 16. The system was not studied in the living worm, and reference must be made to the drawings for such details as it is possible to portray. Longitudinal sections show capillaries in the epidermis. In some of my sections they appear to be specially large and numerous in the 6th segment.

## IV.—Relative Position of *Dichogaster lageniformis*.

I confess to having considerable difficulty in finding the exact place which the new worm fits. It may be asked in the first instance—Is it a *Dichogaster* at all? So far as the setæ, extent and position of the clitellum, gizzard and œsophageal glands are concerned it agrees with the original type. The testes and ovaries are also in the normal position, but this would apply to all the genera of the family. *D. damonis*, the type, has only one pair of spermathecæ, but the more recent diagnosis allows of either one or two pairs. In the type one finds the setæ of certain segments missing, there are vesiculæ seminalis of a special kind, each oviduct opens separately instead of being fused, and the salivary glands in the anterior segments seem to be confined to the first three segments.

On the other hand, the recent additions to the list of species include many forms which differ widely from the type. As understood to-day, the genus *Dichogaster* may include worms which have either one or two pairs of spermathecæ, one, two or three pairs of prostates, penial setæ present or absent, spermathecæ with or without diverticula, girdle saddle-shaped or ring-formed, either two or three pairs of œsophageal glands, and a number of other variations. I do not know of any character in the worm under consideration which makes it impossible for it to fit into this genus, or which would ally it more closely to any other. Our information about the presence or absence of a tongue or taste organ, and the existence of one or more peptonephridia in other species is not very complete, but these are not generic differences.*

If we sum up the most important points we shall be able to discover what species come nearest to *D. lageniformis.* There are two pairs of spermathecæ and two pairs of prostates. There are no penial setæ, and the diverticula of the spermathecæ are only imperfectly developed. There are three pairs of œsophageal glands, the girdle covers segments 13–20, and the oviducts have but one pore. In some of these particulars *D. cæcifera,* in others *D. inermis* and *D. heteronephra* are related thereto. But these are all very large worms, while our present species is a pigmy, and they vary in many other ways as well.

*D. lageniformis* must therefore, for the present, be regarded as occupying a position somewhat apart, the difficulty of placing it being enhanced by the fact that we have no clue to its original home.

## V.—Bibliography.


1. 1888. Beddard—Quart. Journ. Micr. Sci., xxix. pp. 235–82 (2 pls.). Structure of *Urochæta* and *Dichogaster*.
2. 1895. ,, A Monograph of the Order Oligochæta.
3. 1886. Benham — Quart. Journ. Micr. Sci., xxvii. pp. 77–108. Studies on Earthworms (p. 94).
4. 1890. ,, Quart. Journ. Micr. Sci., xxx. pp. 201–315. An Attempt to Classify Earthworms.
5. 1915. Friend—Ann. Applied Biol., ii. pp. 195–208 (6 pls.). Studies in Enchytræid Worms: *Henlea fragilis* Friend.
6. 1916. ,, Journ. R. Micr. Soc. Alien Oligochæts in England: *Kerria rubra* sp. n.
7. 1889. Michaelsen—Jahrb. d. Hamburg wiss. Aust., vi.
8. 1891. ,, Jahrb. d. Hamburg wiss. Aust., ix. p. 66.
9. 1891. ,, Arch. für. Nat., p. 202.
10. 1900. ,, Das Tierreich: Oligochæta.
11. 1915. Stephenson—Mem. Indian Museum, vi. pp. 35-108 (4 pls.). On Some Indian Oligochæta.


* See Benham, Quart. Journ. Micr. Sci., xxxi. (1890) pp. 288–89.

## XII.—*Some Suggestions regarding Visual Efficiency in the Use of the Microscope and other Optical Instruments.*

By J. W. Purkis, A.R.C.Sc.

(*Read May* 17, 1916.)

The paper which I have the honour to bring before you to-day deals with the relations of the conditions of light prevailing in the field of optical instruments, and that of the light in the surroundings where the instruments are used. It attempts to show how intimately these factors are connected, the bearing they have on the visual efficiency and comfort of the observer, and suggests some simple regulations that seem desirable where accurate observations for a prolonged time are of importance.

As I have not had any considerable amount of experience with the Microscope, I am keenly alive to the fact that some of my remarks, particularly with regard to that instrument, may not carry general assent. I wish, however, to make it clear at the outset that anything I have to say is only in the nature of suggestions, and if these should act as a stimulus to discussion and lead to interest being aroused on the matter in question, they will have fulfilled their purpose.

Its importance was first brought home to me as a matter of practical experience. Engaged for a time in working with instruments of the spectro-photometer class, measuring densities of photographic plates and absorptions of dyes, and with comparative instruments employing the bi-prism to divide the field for testing the equality of films, I soon found out it was necessary to devise certain precautions, if the observations were to be carried out with accuracy for any length of time, otherwise eyestrain and fatigue, and with these of course diminished accuracy, very rapidly set in. I eventually succeeded in overcoming this, and being able to work for three to five hours on end, without sacrificing accuracy to any very perceptible extent, and without any discomfort or eyestrain, by the expedient of adjusting the light of the surroundings as nearly as might be possible to that prevailing in the field of the instrument. For example, I might be testing dark blue coloured films for two hours, each sheet being tested down each side in turn and then in the centre, thus practically covering the whole sheet, and during that time the window was shuttered, the door was shut, and an electric lamp was used, well shaded to give only

a small diffused general light to the room by reflection from the wall. This might be followed by an examination of light yellow film, when the shutter would be leant away from the window, and the door set ajar to get a comparatively bright light from wall and ceilings. In either case the main consideration was to approximate the light outside to the luminosity of the field of the instrument. With the spectro-photometer, taking the same care to efficiently mask off superfluous light, internal as well as external, I also obtained great benefit both as regards accuracy and comfort.

This may seem exceedingly simple, and yet the general reasons and underlying principles, which form the subject of the following remarks, do not appear to me to have met with sufficient recognition or application in the use of optical instruments generally.

Broadly speaking, it appears to me that the rapid falling off in accuracy of observations, when these are made under the usual conditions, are mainly the result of the efforts of the eye to adjust and accommodate itself to the more or less rapid succession of "shocks" administered to it by the frequent changes of the general luminosity of the field of vision, and that this kind of eyestrain or fatigue plays a far greater rôle than any diminution of the sense of perception by the retina, owing, for example, to the extreme brightness of the objects examined.

We have to first recognize the principle that the eye adjusts itself comparatively slowly to different luminosities, and, of course, clearness of sight, and therefore accuracy, depend on the adjustment of the eye being correct.

Let me illustrate this slowness of adjustment of the eye by reference to well-known facts. The eye is said to be blinded if from a dark, that is, a comparatively dark luminosity, by which it has been seeing, it looks at a bright, that is, a comparatively bright luminosity, and then back at the original comparatively dark luminosity. It can now no longer see properly, but takes a certain time to readjust itself, for the shock to wear off, the time being proportional to the contrast between the luminosities.

The following table gives a few typical instances where such temporary "blinding" would take place:—

| Dark, or Comparatively Dark Luminosities. | Bright, or Comparatively Bright Luminosities. |
|---|---|
| 1. Bright daylight .. .. .. | The sun. |
| 2. Interior daylight, as in a church .. | Bright daylight. |
| 3. Interior artificial lighting .. .. | An artificial illuminant itself, e.g. incandescent wires or mantle. |
| 4. Photographer's dark-room .. .. | Interior artificial lighting. |
| 5. Clouded moonlight .. .. .. | Motor head-lights. |

It will be observed that the same light which is placed under the heading "dark" follows in the next line under the heading "bright," thereby bringing out that "dark" and "bright" are

merely comparative, and that the controlling factor (or more correctly, one of the controlling factors) is that of contrast between the successive luminosities. In any of these examples the eye takes an appreciable time before it has recovered from the "shock" imposed on it by the comparatively bright light and can see again at its best in the comparatively dark light.

It is obvious that it is not the brilliancy of the light itself which is the main factor to cause the strain and consequent lack of accuracy in seeing, for under normal conditions no fatigue is caused by prolonged observations in daylight, for example, or with good artificial illuminants. The eye accommodates itself to a very considerable range of luminosities, and, unless the luminosity is rapidly changed, works easily, with accuracy and without strain.

Endless instances might be cited to show how apt we are to judge of particular degrees of luminosity simply by reference to others, and how the same luminosity affects or does not affect the eye in consequence. If, for example, the artificial light in a room is turned on in the day the eye suffers no inconvenience; one can look at it not only without producing so-called blindness, but with a feeling of astonishment, arising from the impression that the voltage or gas pressure should be so bad that such a poor light is obtained.

Or consider the opposite case, when a photographer with his eyes adjusted to daylight or bright artificial light goes into the comparatively feeble light of his dark-room. Suppose he wishes to develop panchromatic plates, and is using an ordinary Wratten and Wainwright green safelight. Many can testify that upon entering the dark-room they cannot detect whether the green light is on or off, whilst after twenty to thirty minutes not only can they distinguish the objects in the surrounding room, but the light appears so bright that they begin to wonder whether it is possible for so bright a light to be safe with panchromatic plates.

The examples cited suffice to show that whether we move from a comparatively dark luminosity to a comparatively bright one, or *vice versa*, the adjustment of the eye to its new surroundings is a slow process; it might even be said to be a very slow process, since the eye seems to improve in seeing-power for one or two hours after going into a dim light, although the improvement gradually falls off and becomes less and less marked after the first fifteen to twenty minutes.

For want of a better expression, I have used the term "shock" to designate the effect on the eyes of sudden changes from dark to bright luminosities, or *vice versa*, but there is also the further effect, which I shall refer to as "strain," arising from the conscious or unconscious effort of the eye to accommodate itself to the new degree of luminosity, and to see clearly, before in fact it has had time to adjust itself properly to the new circumstances.

The fact that these factors of "shock" and "strain," which retard clearness and accuracy of vision in proportion to the degree of change in the general luminosity, points to a simple manner in which the adjustment of the eye to the new luminosity may be hastened.

If, on leaving daylight to enter the dark-room with the green safelight, the ordinary artificial light is turned on as well for, say, two minutes, then after turning this out, one can see well enough by the safelight in five to ten minutes. In other words, the twenty to thirty minutes required if we proceed direct from daylight to the dark-room illuminated by the green safelight, has been reduced to seven to twelve minutes by the expedient of taking the contrast in two stages. The strain on the eyes, always naturally greatest at the start, is thereby lessened, and they are, so to say, helped to get on the way.

On coming into a bright light from a feeble one, the recovery of the eye to perfect adjustment is a much quicker one, for the same amount of contrast, than in the previous one; but here, too, the same principle holds good, and the recovery may be hastened by subjecting the eyes to an intermediate stage of luminosity.

These facts lead, indeed, to the somewhat interesting speculation whether it might not be possible, by gradually increasing or gradually decreasing luminosity in a number of successive stages, in order to eliminate as far as possible all shock and strain to the eye, to enable it to see by a very much brighter or a very much feebler light than is practicable under ordinary circumstances.

The "strain" referred to in this paper so far has related to the effort of the eye to see sharply in light of a changed luminosity; but there is a further potent cause of "strain," in using optical instruments, when the eye endeavours to see sharply that which the instrument has not reproduced sharply, or that which is not well defined in the original.

This would appear to be a prime cause of inaccuracy in the observations of novices when working with scientific instruments, in many of which the division line between fields, or the scale lines, are wanting in sharpness from too high a magnification, or other avoidable or unavoidable causes. In the Microscope, besides any lack of sharpness in the original or the image, the further factor comes in that only one plane of the object is in sharp focus at a time. The novice in his anxiety to see clearly strains the eye in trying to force it to focus sharply beyond its powers of accommodation, and the fatigue so caused rapidly leads to less instead of greater accuracy.

This points to the fact that in the use of all optical instruments care should be taken to first ascertain and consider whether lack of sharpness of fields, boundary lines, scales or the image or part of the image itself, is avoidable or not, since when such want

of sharpness cannot be rectified by focusing, or other adjustments, the eye must make the best of a bad job, and should, if possible, avoid the attempt to see such details sharply, thereby causing "strain," and impairing its accuracy for further observations for the time being.

To see with constancy and maximum accuracy the eye must not be called upon to make any violent adjustments from the normal, and must not be faced with sudden changes of luminosity. If it is, it must be given ample time to adapt itself to the new conditions. This also represents the maximum degree of comfort.

The eye should look almost casually at the field, without having to exert itself. Looking casually is not synonymous with looking carelessly. What the eye cannot see by quietly looking at an object, it cannot see by what may be called concentrated gaze or stare.

I come, lastly, to a few observations concerning the use of a few specific optical instruments. They are, as already mentioned, only put forward as suggestions.

*The Microscope.*—It would seem desirable in the case of a prolonged series of observations, when employing a bright field of view in the instrument, to see that the room is also sufficiently brightly illuminated, or, conversely, if the room cannot be illuminated to accommodate itself more or less to the field of view in the instrument, the illumination of the field itself might be suitably modified.

It would seem desirable when examining objects with different objectives or eye-pieces in frequent and rapid succession, to avoid great alterations in the luminosity of the field as far as possible, and, if necessary, to attempt to modify the luminosity so as to bring them more closely into correspondence.

The shading of the illuminant from the eye, in order to avoid superfluous flare, is so generally recognized as to scarcely need drawing attention to, but it may be worth while pointing out that if there is any specially bright portion of the field with which one is not concerned, it would be useful to move it out of the field, if possible, or cover it up, so as to avoid unnecessarily great contrasts of luminosity in the field of observation. Any conscious straining to see parts of an object not in sharp focus should be avoided.

Lastly, a word on the question of preparing the eye for careful observation. It has, I believe, been on various occasions recommended by experienced workers to go in the dark for some time before entering upon careful observations. This somewhat tedious operation would appear to be unnecessary, if it is a question of any continuous observations, as the improvement in visual perception due to resting the retina is counterbalanced by the strain on the eye in accommodating itself to the new conditions of luminosity. To rest the eye in approximately the same

amount of light as appertains in the field of view of the instrument would seem to be more effectual.

My remarks, it should be noted, only deal with the question of prolonged observations, where the main desiderata are continuous accuracy of observation together with the minimum of fatigue or strain, two things which, in fact, as already shown, go together and depend on one another. Where it is merely a question of single or isolated observations, other factors may, and probably do, enter into consideration, so that my remarks would not necessarily apply in full in such cases.

*Instruments with Divided Fields: The Spectro-photometer, Photometers in general, Polarimeters.*—In these a rhomb is often used to bring the two fields together, and the division lines between the fields is not as a rule very sharp. It is here often better to put the division line distinctly out of focus, and in any case the eye must do its best to ignore the division band.

These instruments generally suffer somewhat badly, sometimes very badly, from scattered light, which affects accurate observation. Much of this can be eliminated by proper masking, notwithstanding the use of brass tubes of small diameter.

In spectrum work the part not under observation or measurement should be cut off, especially if it is the brighter portion.

*Range-finders.*—These being mostly used in the open, and the eyes therefore adjusted to daylight, whilst the field of the instrument may be considerably less bright, the case offers some analogy with that of the photographer's dark-room and the external lighting.

To see with the greatest accuracy, constancy, and without strain, it would be necessary to accustom the eyes to the light in the field of view of the instrument before taking observations. As it would be impracticable to keep the eyes glued to the instrument a sufficiently long time in advance, it appears reasonable to assume that the use of goggles with neutral tinted glasses which cut down the luminosity of the outside light to approximately that of the field in the instrument would prove serviceable. The ratio between these two luminosities probably bears a more or less constant proportion; when the day was bright the field would be proportionately brighter, and *vice versa*, so that for any particular range-finder the same pair of goggles would serve under varying light conditions.

Some simple device would, of course, be necessary, so that when the eyes were placed to the instrument the goggles would be automatically raised, and when they were removed from the instrument they would return to their position in front of the eyes, without the admission of extraneous light. By means of ledges on the instrument and on the goggles this should be an easy matter.

# OBITUARY.

## Charles Lees Curties. 1861–1916.

We regret to record the death of Mr. C. Lees Curties, at the early age of fifty-five. He had been a Fellow for twenty-two years, and had served more than one term on the Council of the Society as trade Member, representing the firm of Charles Baker, a position he occupied at the time of his death, besides serving on various committees.

Apart from trade interests he was, as a young man, one of the pioneers of Photomicrography, as references to his work in several of the earlier books on this branch of Microscopy testify, but the death of the founder of the firm in 1894, and of his father—who had succeeded to the business—a few years later, left him but little leisure for aught else but the problems inseparable from the conduct of a business in scientific instruments. These problems were more particularly numerous and perplexing in his case owing to the fact that the staff on whom he had to depend had grown old with the original founder, and were thus incapable of appreciating the changes which the vast expansion of science about that time rendered necessary.

That he successfully piloted the business through these difficulties, and has left to the succeeding partners, one of whom is his son, a business securely grounded on modern principles, with largely extended workshops and showrooms, rebuilt within the last ten years, is no mean record of industry and perseverence.

We cannot close this short memoir without referring to his very extensive knowledge of all kinds of scientific instruments, the foundation of which was laid in very early boyhood, when, as was at that time the custom, his father lived with his family over the business premises; there were few scientific instruments, however obscure their use and antiquated their design, that Charles Curties could not name, give some idea of the use for which it was designed, and the probable date of manufacture.

H. F. Angus.

# SUMMARY OF CURRENT RESEARCHES

RELATING TO

# ZOOLOGY AND BOTANY

(PRINCIPALLY INVERTEBRATA AND CRYPTOGAMIA),

# MICROSCOPY, ETC.*

## ZOOLOGY.

### VERTEBRATA.

#### *a.* Embryology.†

**Development of Horse.**‡—J. Cossar Ewart has made a study of the development of the horse during the third week. He begins with a discussion of the previous work on young horse embryos by Bonnet, Martin, and Hausmann. A description is then given of the reproductive organs and fœtal membranes at the end of the third week. The external characters, nervous system, sense organs, alimentary canal, notochord, heart and blood-vessels of the three-weeks' embryo are then discussed. The early developmental stages in the horse and the sheep are then compared.

From the second week onwards the horse follows a route of development different from that of all the other Mammals hitherto studied. There is no evidence that the development is arrested at any stage in the horse, as it is in the roe deer, where after the cleavage stage is reached little or no progress is made for several months. At the end of the third week of gestation, the blastocyst measures 50 mm. The trophoblast at the end of the third week differs in several essential points from that of sheep and pig and other Ungulates hitherto examined. There is a continuous sheet of nutritive coagulum between the trophoblast and the yolk-sac endoderm. In the vicinity of the embryo the yolk-sac consists of endoderm and a layer of splanchnic mesoderm, but from the exocœlom to the sinus terminalis it is only represented by

* The Society are not intended to be denoted by the editorial "we," and they do not hold themselves responsible for the views of the authors of the papers noted, nor for any claim to novelty or otherwise made by them. The object of this part of the Journal is to present a summary of the papers *as actually published*, and to describe and illustrate Instruments, Apparatus, etc., which are either new or have not been previously described in this country.

† This section includes not only papers relating to Embryology properly so called, but also those dealing with Evolution, Development, Reproduction, and allied subjects.

‡ Trans. Roy. Soc. Edinburgh, li. (1915) pp. 287–329 (10 pls. and 21 figs.).

endoderm. Beyond the sinus the yolk-sac endoderm is intimately connected with the trophoblast. At the middle of the third week the splitting of the mesoderm is only beginning, and the amnion is only represented by indistinct lateral ridges. At the end of the third week the amnion is complete, and the mesoderm is split so as to form a cœlom and a small exocœlom. There is no indication of an allantoic diverticulum at the middle of the third week, but it has appeared at the end.

The 21-day embryo has over twenty somites, and is hook-shaped. The nervous system is represented by a fore-brain with optic vesicles, by an indistinct mid-brain, by a hind-brain adjacent to which are otic vesicles, and by a spinal cord completely closed except at the caudal end, where it opens by a neuropore into the cavity of the amnion. The alimentary system consists (1) of a fore-gut from which branchial pouches project outwards towards shallow branchial furrows lying between branchial arches, (2) of a mid-gut which communicates by a yolk-stalk with a large yolk-sac, and (3) of a short hind-gut from which a cloacal rudiment projects upwards, and an allantoic diverticulum extends backwards. The circulatory system is represented by a sinus venosus, an atrium, a ventricle and a bulbus arteriosus; by two pairs of aortic arches, two dorsal aortæ, by vitelline and other arteries, and by vitelline, cardinal, umbilical and other veins. A notochord and branchial arches represent a skeleton, and excretory organs are represented by Wolffian bodies and pronephric ducts.

In the comparison between horse and sheep embryos it is pointed out that even at the stage characterized by four pairs of mesodermic somites the horse differs from a sheep at the corresponding phase in its life-history, and that, as development proceeds, the differences, more especially in the fœtal appendages, become more pronounced.

**Derivatives of Human Pharynx.***—B. F. Kingsbury considers the pharynx as consisting morphologically of four zones: the hypobranchial, the floor, the epi- or hyper-branchial, and the lateral wall or branchial region proper. The investigation of the growth shiftings in the domain of the pharynx has to deal with three parts: (1) that of the dorsal wall and cephalic portion, including the first (and second) branchial arches and the first and second pouches; (2) that of the tongue and the corresponding portions of the pharyngeal floor; (3) the caudal and ventral portions, including the third and fourth pouches and clefts and the second cleft, together with the thyroid gland. It is mainly the last section of the pharynx development that is considered in the present paper.

In a 3 mm. embryo the thyroid gland is present as a median out-pocketing, still broadly in communication with the caudal limb of the first branchial pouch and in immediate contact with the truncus aorticus. Its history and that of the third complex is followed, and the effect of the descent of the heart is analyzed. The epibranchial placodes, the thymus, the parathyroids, and ultimobranchial body are then discussed.

Kingsbury passes to a consideration of endocrine or internally

* Amer. Journ. Anat., xviii. (1915) pp. 329–97 (5 pls.).

secreting glands, laying stress on their frequent correlation or physiological linkages and their diversity of origin. He does not find conclusive evidence of endocrine glands in either ovary or testis. It suggested that the feature common to all endocrine glands is, that they arise from or have been evolved out of structures quite different. "They appear by a process of metamorphosis, and their persistence is attended by a 'metaphysiosis'—if one might coin the word—to which is due their influence on bodily metabolism and growth." In all cases there is an element of regression, and this is connected with their effect on the general bodily growth and metabolism.

**Paraphysis and Pineal Region of Garter Snake.***—B. W. Kunkel has studied the development of the parietal region in *Thamnophis radix*. There can be little doubt left regarding the presence of a parietal organ in certain stages of the ophidians. The structure described by the author arises as an evagination from the roof of the diencephalon anterior to the epiphysis and becomes a hollow spheroid, consisting of a single layer of cells. Against this interpretation he mentions and discusses three facts: it appears after the epiphysis, it is widely separated from the epiphysis, and it fails to migrate dorsally. If the organ described is a parietal organ and not something unique, then the author's observations show the complete independence of the parietal organ and the epiphysis. In the garter snake there is from their earliest appearance a considerable interval between them on the roof of the diencephalon, and in this interval the superior commissure subsequently appears.

**Mesonephric Corpuscles of Some Ruminants.**†—J. L. Bremer has found in embryos of sheep, cow and deer a hitherto undescribed type of mesonephric corpuscle. By "corpuscle" he means the entire blind end of an excretory tubule; by the term glomerulus the knot of capillaries, covered by the inner wall, projecting into the expansion of this end. A corpuscle (Malpighian) then includes ordinarily a glomerulus, the slit-like crescentic cavity continuous with that of the tubule, and the outer layer or Bowman's capsule. The peculiarity observed in the *anterior* corpuscles in the sheep, cow and deer consists in the absence of a true glomerulus and the undifferentiated state of Bowman's capsule.

**Relation of Notochord to Hypophysis.**‡—Wayne J. Atwell has inquired into the relation of the chorda dorsalis to the endodermal component of the hypophysis in the rabbit and in the chick. In the rabbit the anterior end of the notochord tends to maintain its connexion with the endoderm represented by a bud from Seessel's pouch. The endoderm cannot be said to contribute to the formation of the hypophysis of the rabbit, and the notochord does not usually come into connexion with the wall of the hypophysis.

In the chick in early stages the anterior end of the notochord is attached to a solid bud of epithelium which extends from a point slightly

* Anat. Record, ix. (1915) pp. 607–36 (41 figs.).
† Anat. Record, x. (1915) pp. 1–6 (3 figs.).
‡ Anat. Record, x. (1915) pp. 19–38 (12 figs.).

ventral to the cephalic end of the fore-gut. By the growth of the fore-brain and the sharpness of the cervical flexure, this endodermal bud comes into contact with the growing hypophyseal sac and fuses with it. The fusion occurs at about the time the oral membrane ruptures. The fused bud soon loses its connexion with the endoderm. It remains fused with the dorsal wall of Ratke's pocket, however, and contributes a small mass of cells to the hypophysis-primordium. The notochord still shows indications of an attachment to the fused bud. Thus the attachment of the notochord (which is gradually becoming less and less a definite attachment) is transferred from Seessel's pouch to Ratke's pocket. The relation of the notochord to this small endodermal increment of the hypophysis, and the fact that no lumen is to be found, tend to show that the endodermal contribution to the hypophysis is unimportant and accidental.

**Hermaphroditism of Gilthead.***—E. J. Bounhiol and L. Pron describe the occurrence of double gonads and ducts in *Chrysophrys aurata*, well-known to be a hermaphrodite fish. The organs on the left are most strongly developed—an asymmetry common in fishes. The important point, however, is that the ovaries and testes were both mature. The hermaphroditism is thoroughgoing and simultaneous, not protandrous. The authors do not refer to previous statements as to the hermaphroditism of this fish.

**Somatic Sterility.**†—Maynie R. Curtis and Raymond Pearl use the term "somatic sterility" to distinguish obstructions to egg-laying (in fowls) due to accident or disease affecting the individual, and not inherited from her ancestors. Sterility due to these causes, which may include not only actual obstructive lesions of the genital organs, but also a general lowering of the physiological tonus of the individual to such an extent that it does not form yolk, is distinguished from sterility due to a lack of the genes for egg production.

It was found that three of four birds which belonged to high-laying strains, and which did not fulfil the expectation based on a knowledge of their genetic constitution, failed because of the impossibility of a yolk entering the oviduct. Two other birds belonging to segregating families (one of these had proved herself a high producer by her own winter record) showed the same reason for not laying. It was found that birds which ovulate, or return partly formed eggs, into the body cavity usually show the nesting instinct. The nesting records show a rhythm similar to egg records of normal birds, and it seems probable that they are the normal resultant of the ovulation.

Confirmation was obtained of the following conclusions previously reached :—In case of stoppage of the duct at any level, the duct on both sides of the point of stoppage passes through the same cyclic changes, co-ordinated with the cyclic changes in the ovary, as a normal unobstructed duct ; the duct functions only as far as it receives the stimulus of the advancing egg ; absence of pressure from the funnel

* Comptes Rendus, clxii. (1916) pp. 273–6.
† Journ. Exper. Zool., xix. (1915) pp. 45–59.

does not prevent or apparently greatly retard ovulation; increased internal pressure may therefore be the most important factor in normal ovulation; yolks of partly formed and fully formed eggs may be absorbed rapidly and in large numbers from the peritoneal surface without causing any serious derangement of normal metabolic processes.

**Development of Lymphatics in Chick Embryo.***—Eleanor L. Clark finds that the primary superficial lymphatics of chick embryos form a rapidly growing, frequently anastomosing capillary network, with numerous open connexions with the venous system. For over twenty-four hours the pressure in these earliest lymphatics remains less than the side-pressure in the connecting veins, and, consequently, there is no lymph-flow in the early plexus. Instead, it contains blood which backs up into it from the communicating veins.

The pressure of the fluid in the lymphatics gradually increases and finally overcomes that of the veins. The first lymph-flow which is then established is feeble and easily disturbed. It gradually becomes more rapid and steady, but its course is easily altered by various mechanical factors. A day later, the pressure in the superficial lymphatics has increased still more, while, for various reasons, the outflow into the veins is interfered with. At certain points two conflicting pressures are present, and here the lymph-flow becomes sluggish.

The endothelium of these early lymphatics responds to the passage of fluid over its interior by the differentiation of definite ducts or channels out of the indifferent primitive network. With the increased flow of lymph these channels enlarge and more channels form. That the formation is due to the lymph-flow and to mechanical factors rather than to arbitrary predetermination is evident from the frequent variations which occur in the position of the main ducts in chicks of the same stage. The endothelial wall of the early lymphatics also responds to the increased pressure caused by interference with the lymph-flow and the damming back of fluid, by expanding to form sac-like enlargements. The size which these sacs may attain is influenced to some extent by the looseness of the surrounding tissue. The general result of the study is that lymphatic endothelium reacts to the pressure and flow of the fluid inside the walls of the vessels, and that the formation of lymph trunks and of lymph sacs from a primitive plexus represents a response to such stimuli.

**Influence of Exercise on Growth of Rat.**†—Shinkishi Hatai has experimented with the albino rat in order to discover the effect of long-continued exercise. Long-continued exercise, 90–180 days in revolving cages ("equivalent to a period of 7–14 years in man"), produces many striking modifications. The heart, kidneys and liver show an average excess of about 20 p.c., while the spleen shows a similar amount of deficiency. The brain-weight shows an average excess of 4 p.c., while no change was observed in the spinal cord. The ovaries showed

* Amer. Journ. Anat., xviii. (1915) pp. 399–440 (9 figs.).
† Anat. Record, ix. (1915) pp. 647–66.

an excess of 84 p.c., the testes of 12 p.c. The hypophysis and supra-renals respond differently to exercise in the two sexes. They show, as the result of exercise, an approach to the relations characteristic for the Norway rat. The exercised rats were either entirely free from lung infection or but slightly affected. The control rats were badly infected. Lung infection is not responsible for the changes observed in the organs. Exercise for 30 days showed in most organs modifications similar to those observed in rats exercised for 90–180 days. In the exercised rats the heart-weight and amount of exercise taken are highly correlated.

**Growth and Weight in Albino Rat.***—Helen Dean King finds that in similar environmental conditions the growth of rats within a given colony tends to be uniform; but in dissimilar conditions different weights result for the same ages. The male is usually heavier than the female at birth and afterwards, but the female increases in weight much more rapidly than the male during the early stages of development and reaches her maximum much earlier. Variability in the body-weight, as measured by the co-efficients of variation, is greatest when the animals are about 60 days of age. It decreases slightly at 90 days, and after 120 days remains practically constant until the animals are about one year old. Very young female rats seem to show as great a range of variability in body-weight as do the males, but the males are more variable than the females at all later stages of growth. The average co-efficient of variation for the body-weights of the 50 male rats used in the investigation was 13·6; that for the females 12·1. There is apparently a direct correlation between the rapidity of growth and the variability in body-weight after the animals have reached 60 days of age. Fraternal variability is less than racial variability; for the male about 70 p.c. of that of the general population, for the female about 55 p.c.

**Development of Lymphatic System.**†—Charles F. W. McClure asks whether the endothelium of the lymphatic system arises, at any place or time, in a discontinuous manner and independently of that of the veins. His answer is that the development of the general vascular system—both hæmal and lymphatic vessels—is a uniform process, which consists in a local genesis of endothelium from mesenchymal cells and a growth of endothelium after it has once been formed. The lymphatic problem, in its broadest sense, should not be interpreted in terms either of a venous or non-venous origin, but rather in terms of the uniform phases of genesis and growth which may characterize the establishment of vascular channels in general.

**Mesenchyme Cells of Teleost Yolk-sac.**‡—Charles R. Stockard has studied the wandering mesenchymal cells on the living yolk-sac, and their developmental products—chromatophores, vascular endothelium and blood-cells. The yolk-sac has only one really definite

* Anat. Record, ix. (1915) pp. 751–76 (5 figs.)
† Anat. Record, ix. (1915) pp. 563–79.
‡ Amer. Journ. Anat., xviii. (1915) pp. 525–94 (35 figs.).

continuous membrane—the ectoderm; a true endodermic layer is absent, though a superficial syncytium, the periblast, fuses with the actual yolk surface. The mesodermic layer is represented by numerous separate wandering mesenchymal cells, which may be seen, through the transparent octoderm, moving over the surface of the periblast.

The wandering cells begin to migrate away from the embryonic shield when the embryo is about forty hours; they come chiefly from the caudal end; they pass into the so-called sub-germinal cavity. They are closely alike at first, but they soon exhibit differences. Many become elongate spindle cells with delicate filamentous processes, sometimes producing a stellate appearance. Others are more amœboid with mobile conical pseudopod-like processes. Somewhat later there appear more slowly moving cells, circular in outline, with short thick pseudopods.

Those with the conical pseudopods accumulate black or brown pigments. The black chromatophores gather along the walls of vessels, and eventually form syncytia. The brown ones never become so massive; they also gather round the walls of the vessels, but they never form a syncytium. The chromatophores never change into any type of blood cell.

The elongate spindle cells become aggregated in linear groups which form tubular vessels. The wall of the early blood vessels thus formed is very irregular, with spaces between the component cells. Corpuscles are often caught in these spaces or entangled in the filamentous processes of the endothelial cells. It often looks as if endothelial cells were changing into blood cells, but that is not the case. Thoma's generalization that larger vessels arise from a network of capillaries is not true in this case. Nor do vessels arise ontogenetically as portions of the cœlomic epithelium. The vascular lumen is originally continuous with the segmentation cavity, never with the cœlom.

The small globular cells with short pseudopods become erythroblasts, and change about the fifth day from spherical to flattened and ellipsoidal. Thus, in the same environment, superficially similar mesenchyme cells differentiate in four directions of cytomorphosis—two kinds of chromatophores, endothelial cells, and blood corpuscles.

### *b.* Histology.

**Melanophores of Amblystoma Larvæ.***—Henry Laurens has studied the reactions of the melanophores in the larvæ of *Amblystoma punctatum* and *A. opacum*. Normal seeing larvæ and eyeless larvæ show different states of the melanophores under identical conditions of illumination and darkness, after they have been kept for some time under these conditions. The melanophores of normal seeing larvæ that have been kept for longer than three to five days in bright diffuse daylight on an indifferent background are contracted; those of eyeless larvæ are maximally expanded. After prolonged darkness those of the seeing larvæ

* Journ. Exper. Zool., xviii. (1915) pp. 577-638.

are expanded, those of the eyeless larvæ contracted. The melanophores of normal larvæ kept in bright diffuse daylight on a white background are contracted; on a black background, expanded.

On the other hand, the primary reactions of the melanophores of normal and eyeless larvæ are identical, light bringing about an expansion, darkness a contraction. The response of the eyeless larvæ is much slower. After some time the condition undergoes a secondary change, as above indicated.

The melanophores of blindfolded larvæ, when illuminated, act like those of eyeless larvæ—they expand and remain so. In darkness they act like those of normal seeing larvæ—at first they contract, but after five days or more they expand. The reactions of recently metamorphosed young adults are like those of adults, but slower and less complete. The melanophores of very young larvæ do not react to light, darkness or backgrounds.

The melanophores in isolated pieces of skin, suspended in drops, do not react to daylight, to light from a Nernst glower, or to darkness. They contract in the light of an arc-lamp, probably responding to the ultra-violet rays. A 0·01 p.c. solution of chloretone inhibits this effect. Solutions of NaCl, KCl, and atropin have no effect. Atropin sulphate (1 p.c.) and curare (0·2 p.c. and 0·1 p.c.) cause expansion in larvæ, not in isolated pieces of skin. Chloretone produces expansion, and inhibits the effects of light and darkness. In a "Ringer solution opacum" larvæ will live for twenty days, and the melanophores will respond normally.

Low temperature causes expansion, high temperature (above 28° C.) contraction. The melanophores are under both spinal and sympathetic nerve control, the former being relatively unimportant. The sympathetic fibres leave the spinal cord by means of the first or second, possibly both, spinal nerves. When the portion of the central nervous system in front of this is destroyed, the secondary reactions no longer take place, though the primary reactions are normal. The latter are due essentially to direct stimulation, helped by stimulation through the eyes. The secondary reactions of normal seeing larvæ are due to nervous activities, set up by stimulation of the retinæ, but in which supposed sensory endings in the skin have little or no share. The indirect stimulation at first assists the direct. In a 0·2 p.c. solution of curare the larvæ soon become immobile, and the pigment-cells remain expanded under all conditions. If a small amount of 1 p.c. solution of curare be injected into the body-cavity, the larvæ are rendered immobile, but the melanophores react as usual. If a drop or two of 1 p.c. solution of strychnine be injected, the melanophores soon contract after the cramp begins, which points to a spinal control. If a few drops of 0·01 p.c. of nicotine be injected, the primary reactions take place as usual. An induced current of sufficient strength and duration causes the melanophores to contract in normal larvæ, in larvæ in which the central nervous system has been destroyed, in excised portions of the body, and in isolated pieces of skin. A constant current causes the melanophores to expand. Light, temperature, and electric currents all act directly on the melanophores. Light and electric currents act also indirectly on

the melanophores by means of the spinal and sympathetic nerves. The nerve-endings for the reception of indirect light stimuli are in the retinæ, sensory nerve-endings in the skin probably paying no part.

**Acidophilous Chromosomes and Chromatin Particles.***—Ivan E. Wallin found in sections of lamprey larvæ, 5 mm. in length, that numerous mesenchyme and blood-cells contained nuclei staining a uniform and brilliant red. These were scattered among other cells having similar nuclei, but staining the usual deep blue colour with the hæmatoxylin eosin stain. The cells with the red-stained nuclei showed mitotic division like the others; in some cases both kinds of chromatin were present in the same cell. The author believes this is the first record of a case where the chromosomes in a dividing-cell have definitely taken on the acid stain.

**Blood Counts for Animals.**†—J. J. Wells and J. E. Sutton, jun., have counted the blood-corpuscles in a variety of types. No general statement can be made, covering all animals, regarding the effect of age on the number of erythrocytes. The average number of red and white corpuscles, respectively, per cubic cm., was as follows:—Adult dog, 6,709,300 red and 11,000 white; young puppy, 4,268,560 and 16,290; cat, 9,646,000 and 14,800; rabbit, 6,800,850 and 11,743; horse, 7,894,000 and 8,600; cow, 7,655,350 and 11,600; sheep, 10,354,000 and 8,533; and so on; adult badger, 13,995,200 and 16,220; three-months' badger, 7,880,000 and 14,100; the same badger 4½ months old, 11,440,000 and 10,650; turtle (*Chrysemys elegans*), 756,000 and 12,330; frog (*Rana esculenta*), 591,000 and 10,400. It may be recalled that the number of erythrocytes per cubic cm. is about 5,000,000 for man and 4,500,0000 for woman.

**Fat and Mitochondria in Cardiac Muscle.**‡—H. Hays Bullard finds that the cardiac muscle fibres of Mammals, both fœtal and adult, contain a variable nutritive reserve in the form of droplets of neutral fat, in longitudinal and transverse rows between the myofibrillæ or muscle columns. Fibres with little fat (light by transmitted light) occur side by side with others crowded with droplets (dark by transmitted light), and correspond to the so-called light (non-fatty) and dark (fatty) fibres of skeletal muscle. In inanition the visible fat of cardiac muscle decreases, with fatty foods it increases. The phospholipine (lecithin and related compounds) of cardiac muscle is found in the true interstitial granules (mitochondria), and it is not markedly decreased in inanition, or increased when fats are given in the food. Neutral fat droplets in cardiac muscle do not arise from true interstitial granules. Visible neutral fat is of normal occurrence in the muscle fibres of the bundle of His; only a small amount is found on the nodal tissue of the heart.

* Anat. Record, ix. (1915) pp. 421–4 (1 pl.)
† Amer. Journ. Physiol., xxxix. (1915) pp. 31–6.
‡ Amer. Journ. Anat., xix. (1916) pp. 1–34 (2 pls.).

### c. General.

**Animal Communities on the Sea-bottom.***—C. G. Joh. Petersen gives an account of investigations of animal communities on the sea floor. These investigations were similar to those made in Danish waters and described in earlier reports. They were made in deep Norwegian waters with a view to finding out how far the animal communities were similar in Danish and Norwegian waters at similar depths, and what the deep water might have to show as compared with shallower waters. The "bottom-sampler" was used instead of the dredge, and when modified so that it did not close too soon, it proved efficient at a depth of 700 m. The method adopted was that of taking "profiles" of the water through all depths. The conchiferous molluscs and the echinoderms were selected for the characterization of the communities, these two groups being most abundant, and comparatively little subject to seasonal fluctuations. Depth as such was found to have little influence on the occurrence of communities; temperature had more, but the communities themselves remain constant as regards their characteristic species, notwithstanding changing temperatures. Competition between nearly related species is also a factor, for closely related species of the same genus were never found living on the same area of a given water. Certain small species may occur as attendant species at greatly varying depths. Evidence shows that there is a diminution in the amount of animal life with increasing depth, and the author inclines to the belief that the production in deep water is even less than the low animal content appears to indicate. Full details of the "profiles" taken at the different stations are given in tabular form.

The second part of the same report contains a preliminary note on the valuation of the sea, especially as regards the Kattegat. A computation of the quantity of eel-grass (*Zostera maritima*), of the "useful" animals—that is, those serving directly or indirectly for human food—of "useless" animals, and of food-fishes is given. It would appear that the useless animals, such as *Cyprina islandica*, bulk very largely, and that the food supply for predatory fishes, especially for cod, which feed at a higher level than plaice, is not very abundant.

**Patterns of Animals.**†—J. C. Mottram has analysed the patterns of a number of Mammals, birds, and insects, and discusses their possible value. He has been led to the following three conclusions: (1) obliterative shading in animals is sometimes effected by means of pattern-blending; (2) the outlines of animals are frequently masked by the blending of patterns at or near their margins; (3) patterns having these effects are usually unlike the animal's surroundings, and do not produce protective resemblance.

**Colour-change in Tench.**‡—H. N. Milligan reports on seven experiments on *Tinca vulgaris* which illustrate the readiness with

* Rep. Dan. Biol. Stat., xxiii. (1915) pp. 3–32.
† Proc. Zool. Soc. London, 1915, pp. 679–92 (5 figs.).
‡ Zoologist, xix. (1915) pp. 337–9.

which this fish can change its colour in adaptation to that of its surroundings. There is a lightness of yellow and a darkness of green which the fish cannot exceed, and two hours suffice to enable it to change from one extreme to the other.

**Taillessness in Rat.***—Sara B. Conrow has made a careful examination of three tailless rats, and has found that all of them lacked all of the caudal vertebræ. Besides this, the first lacked one sacral vertebra; the second, two sacral vertebræ; the third, four sacral vertebræ and a lumbar or perhaps two lumbars. In each case the vertebral column terminated in the pelvic region far anterior to the posterior end of the body, showing that the tailless condition was due not to accident after birth, but to a congenital deformity of the vertebral column.

**Secretion in the Thyroid Gland.**†—R. R. Bensley discusses the various views, and concludes that the colloid material is a true secretion-antecedent, representing material formed in the base of the cell for the purpose of direct transport into the vascular channels. Under normal conditions of functioning the secretion is excreted from the cell directly without passing by the indirect route through the follicular cavity. But in other conditions there is an indirect mode, which consists in the condensation of the secretion into the form of droplets having a high content of solids, and the extrusion of these droplets into the follicular cavity.

**Variations in Garter-snake.**‡—Joseph C. Thompson gives an account of the variations in the scales of specimens of *Thamnophis ordinoides*, taken within a radius of 3 kilometres near the Golden Gate. The species presents a remarkably large series of variations. The food consists entirely of large slugs of the genus *Agriolimax*.

## INVERTEBRATA.

### Mollusca.

#### α. Cephalopoda.

**New Species of Argonauta.**§—G. S. Coen discusses the shells of the Adriatic representatives of this interesting genus. He describes *A. monterosatoi* sp. n., showing how it differs as regards shell from *A. argo* and *A. cygnus*.

#### δ. Lamellibranchiata.

**Living Varieties of Cockle.**‖—G. S. Coen discusses and figures numerous living varieties of *Cardium tuberculatum*, or, as it is called, *Eucardium* (*Rudicardium*) *tuberculatum*.

* Anat. Record, ix. (1915) pp. 777–84 (3 figs.).
† Amer. Journ. Anat., xix. (1916) pp. 37–54 (1 pl.).
‡ Proc. U.S. Nat. Museum, xlvii. (1915) pp. 351–60.
§ Ann. Mus. Storia Nat. Genova, xlvi. (1915) pp. 271–5 (1 pl.).
‖ Ann. Mus. Storia Nat. Genova, xlvi. (1915) pp. 299–304 (5 pls.).

## Arthropoda.

### α. Insecta.

**Variation in Head-length of Spermatozoa in Insects.***—C. Zeleny and C. T. Lenay have investigated head-length of spermatozoa in seven additional species of insects, bringing the number studied up to twenty-two species. The new data on the whole substantiate the view that dimorphism in size of spermatozoa is of common occurrence in those groups of animals in which two chromosomal classes of spermatids are frequent. In both the Hemiptera and Coleoptera a great majority of the species studied show a quantitative difference in chromosomal content among the spermatids, though in each case there are some species which show no difference, or only a slight one. "The chromosomal dimorphism of spermatogenesis is represented in the active functional spermatozoa by size-dimorphism. Control of sex, then, merely awaits our ability to separate the two sizes in the living condition and to use them in artificial insemination."

**Early Stages of Development in Some Hymenopterous Parasites.**† F. Silvestri has studied the structure of the egg and the early stages of development in five Chalcididæ. In *Encyrtus mayri*, whose ovum is deposited in the ovum of the Lepidopterous species, *Œcophyllembius neglectus*, the structure of the ovum, the maturation, and the fertilization agree with what Silvestri has previously described in *Litomastix*, *Ageniaspis*, and *Copidosoma*, and the polar bodies behave as in *Ageniaspis* and *Copidosoma*; the polar part of the ovum does not enclose the embryonic cells until the fourth segmentation, thus much later than in *Ageniaspis*: one of the first four cleavage cells differentiates into a germinal cell as in *Litomastix* and *Copidosoma*; the development in this species is mono-embryonic; the embryo is never surrounded by a true cyst of its host, but merely by the tissues and cells of its host, which remain unaltered in character. No chromatin-elimination process was observed in the maturation division or later.

In *Encarsia partenopea* the egg is laid in the body of a young representative of the genus *Aleyrodes*. The activity of the polar globules ends at the third segmentation, after which they exhibit involution, taking no part in the development of the embryo. The posterior pole of the egg, in which the germinal cells are differentiated, is rather constricted off. The differentiation of the first germinal cells begins at the stage when there are eight segmentation-nuclei.

In *Prospatella* (*Doleresia*) *conjugata* the egg is also laid in the body of a representative of the genus *Aleyrodes*. The structure of the egg and early stages of development are as in *Encarsia*, but the polar globules have no marked period of activity, and the first germinal cell is marked at the fifth division instead of at the third.

In *Prospatella berlesi*, the egg of which is laid in the body of the female of *Diaspis pentagona*, there is no distinct "oosome" (a granular

* Journ. Exper. Zool., xix. (1915) pp. 505–12 (8 figs.).
† Boll. Lab. Zool. Scuola Agric. Portici, x. (1915) pp. 66–88 (6 pls. and 4 figs.).

pole-disk distinct from the nucleus) in the oocyte stage as there is in the three forms previously discussed and in some others. The nucleus is in the posterior part of the ovum, not anteriorly as in the previously discussed species. There is only one polar globule formed, and the development is parthenogenetic.

In *Anaphoidea luna*, the egg of which is laid in the egg of *Phytonomus variabilis*, there is no oosome. Polar globules are formed in the same way in both parthenogenetic and fertilized ova. The future germinal cells do not seem to be distinct at the end of the blastoderm stage.

**Vesicles in Integument of Ants.***—Adele M. Fielde refers to her experiments, which went to show that the habitual activities of ants are guided mainly by diverse odours, produced by the ants themselves, and discerned by the "sub-noses" of the olfactory organs, the funicles of the antennæ. These odours are the odour of the domicile or nest, which is discerned through the air by the distal segment of the antennæ; the colony odour, which is discerned through contact of the antennæ with the body of the ant examined; the individual track scent, which is discerned through the tenth segment of the antennæ and through the air; the odour of the queen and of the undeveloped young, which is discerned by the eighth and ninth segments; and the odour of ants of alien species, which is discerned by the sixth and seventh segments. The ant mainly used was *Stenamma fulvum piceum*, which has twelve segments. It is certain that the segments proximal to the sixth do not discern the odours appreciated by the seven at the distal end. Miss Fielde suggests that the vesicles found in groups or scattered over the integument of ants (pits communicating with the exterior by means of a pore) may be producers of the odours. McIndoo's conclusion that the antennæ are not the organs of smell is regarded as unwarranted.

**Genital Armature of Male Ant.**†—H. St. J. Donisthorpe has made a chart showing the variety of terms applied by Hymenopterists to the complex genital armature of the male ants, and explains his own terminology. The annular lamina is the basal ring which lies in front of the other appendages, and is situated under the ninth dorsal segment. The external paramera include stipites, squamulæ, volsellæ and laciniæ. The internal paramera include sagittæ and spatha. The three pairs of appendages which make up the external and internal paramera enclose each other. Besides these there is a subgenital lamina, which is the ninth ventral segment of the abdomen. Finally, in some genera, there is a pair of hairy appendages, the penicilli, attached to the tenth dorsal segment. The author promises further details in a forthcoming book on British ants.

**Experimental Society of Amazon Ants.**‡—C. Emery succeeded in 1908 and 1909 in starting two experimental societies of *Polyergus*

* Proc. Acad. Nat. Sci. Philadelphia, lxvii. (1915) pp. 36–40 (1 fig.).
† Proc. Entomol. Soc. London, 1915, pp. l–liii.
‡ Rev. Suisse Zool., xxiii. (1915) pp. 385–400 (2 figs.).

*rufescens*. A fertilized queen was introduced into a Janet nest inhabited by a society of *Formica fusca*. The first step on the part of the *Polyergus* queen was to kill the *Formica* queen. She then succeeded in being accepted as queen. When spring came the queen laid eggs, which were brought up by the workers of *F. fusca*. In March 1910 the population of the 1908 nest was reduced to three *fusca* workers and the queen *Polyergus*, so Emery united this nest with that of 1909 in which the introduced queen *Polyergus* had laid no eggs.

The spring of 1910 saw the beginning of the army of Amazons. These were at first treated by the *fusca* workers as if they were pets; they were not allowed to go abroad. In the beginning of summer 1911, the Amazons were more numerous and insurgent, and Emery allowed them to pass down an indiarubber tube into a new formicary. Thus he had as a subject of study an army of Amazons which had never been out of the nest nor made any expeditions. Experiment showed that individuals and bands emerging in the vicinity of a colony of *Formica fusca glebaria* proceeded without hesitation to take cocoons back to their nest. The artificially started colony was vigorous in 1912 and 1913; the raids undertaken were usually to nests near at hand; there was sometimes considerable loss. One day, however, over a thousand cocoons and young of *F. fusca glebaria* were brought in as prisoners. A curious case of what looked like mutiny, or it might be madness, on the part of the slaves was observed, and in connexion with it a deadly quarrel between two Amazons.

Among the 1914 observations was one relating to the vigorous opposition which the slaves or auxiliaries sometimes make to the Amazons' expeditions. Forel supposed that the slaves required each year to get used to the occurrence of the Amazons' ways. Emery suggests that the Amazons remain in some measure the pets of the auxiliaries. The veteran observer also noticed a flitting from one nest to another. On the first day the Amazons carried their slaves; next day the slaves transported the young and the Amazons did little. A slave was seen dragging a resisting queen Amazon. Some of the scouting expeditions of individual Amazons are of interest; one of them involved scaling a wall, and falling three times in doing so, yet the explorer returned to the nest.

The individual explorations are of importance because it seems that they lead to the successful raids which have nests of other ants for their objective. Many of the raids, however, lead to nothing, and Emery thinks there is a periodic restlessness which leads to raids of a tentative sort. The author emphasizes the value of the artificial nest in further investigation of the problems of ant-behaviour.

**Sense of Smell in Lepidoptera.***—Adele M. Fielde refers to the well-known attraction of the female of the Great Peacock, Oak Egger, and some other Lepidoptera for the male. The experiment of cutting off the whole of the antenna is too rough; what is needed is an elimination of segment after segment in order to discover where the particular sub-nose susceptible to the female's odour lies.

* Proc. Acad. Nat. Sci. Philadelphia, lxvii. (1915) pp. 93-5.

**Setæ of Caterpillars as Aids in Classification.***—Stanley Black Fracker has made an elaborate study of the chætotaxy in Lepidopterous larvæ and its systematic value. The setal arrangement in every segment of the body in larvæ of the Lepidoptera has been derived from the same ancestral type. This type includes twelve primary setæ, which the author names after the Greek letters. The primary setæ are present in the first instar. They were established before the suborders of Lepidoptera separated from each other, and possibly before the separation of the order from other Holometabola.

The ancestral plan has been modified in three ways, each being more or less independent of the other two. 1. The prothorax shows a tendency to retain the maximum number of setæ; this is a response to the numerous sensory stimuli which this segment must transmit. 2. The mesothorax and metathorax show a partial reduction and considerable modification in response to the necessary mobility of this portion of the body. 3. The abdominal chætotaxy has also been reduced, but the setæ tend to retain their original typical position. Segments 9 and 10 show specialized modifications of the setal arrangement of segments 1 to 8. The setal arrangement in the chief superfamilies is described.

The second part of the memoir is a valuable systematic outline of the families and genera, based on a study of the larvæ. The chief characters used are the head parts, the armature of the body, the spiracles, and the prolegs.

**Experiments with Pomace Fly.**†—Frank E. Lutz has experimented on the influence of natural selection on *Drosophila ampelophila*. In one set the flies were reared at a temperature kept rather close to 20° C., and the adults were given water, but no food. In the other set the flies were reared under normal, i.e. uncontrolled, temperature conditions, and the adults were carefully fed, but not allowed to mate. The duration of the embryonic periods in relation to the duration of the adult life was studied, and two structural characters, the length of the first posterior cell in the wing and the breadth of the wing, were measured. The results were rather difficult, but they demonstrate the reality of natural selection and its influence on mean, variability, and correlation.

**The "Bar-eye" Mutant of Drosophila.**‡—C. Zeleny and E. W. Mattoon have made experiments with a view to testing the germinal uniformity as regards the distinguishing characteristic in a recent mutant, the "bar-eye" race of *Drosophila*, in which the ommatidia are reduced in number and the facets are restricted to a vertical band or bar. The characteristic appeared in a single male in 1913; and the whole race is descended from this individual. The race has undergone no apparent change during the two years of its existence. Three successive selections for high numbers of facets in the "bar-eye" race

* Illinois Biol. Monographs, ii. (1915) pp. 1–169 (10 pls.).
† Bull. Amer. Museum Nat. Hist., xxxiv. (1915) pp. 605–24.
‡ Journ. Exper. Zool., xix. (1915) pp. 515–30 (5 figs.).

increased the mean number of facets from 98·0 to 139·5. Three similar selections for low numbers decreased the mean from 98·0 to 83·7. The lowest individual (89·0) in the "high" lines after three selections is higher than the mean of the "low" strains, and the highest individual (137·0) of the "low" strains is lower than the mean of the "high" strains. Significant progress was noted in each of the three selections in both "high" and "low" lines. There are some differences in variability in the different generations, but no significant change was proved. Regression towards the mean of the general unselected population decreases with successive selections. Regression towards the mean of the parental populations increases with successive selections. This increase makes it improbable that "bar-eye" stock can be raised to the original level by continued selection.

The authors consider that these data show that individuals in any generation differ as regards germinal constitution. If this difference in germinal constitution is solely in the unit factor concerned in "barring," then variability in this unit factor must be assumed. It is, however, more probable that there are other factors concerned in facet number. In that case the selection effect may be due either to variability of single unit factors or to original differences in factorial composition. That it is due in part at least to the latter is indicated by the increase in regression towards the mean of the parental generation with successive selections.

**Housefly as Carrier of Helminth Ova.***—T. O. Shircore reports on an examination of houseflies about the Native Hospital at Mombasa, the result of which was to show that some harboured ova of *Trichocephalus dispar*, *Ankylostomum duodenale*, *Ascaris lumbricoides*, *Schistosomum mansoni*, and *Tænia saginata*.

**Experiments on Eggs of Beetles.**†—R. W. Hegner has experimented with the eggs of the potato-beetle (*Leptinotarsa decemlineata*) and the willow-beetles (*Calligrapha multipunctata* and *C. bigsbyana*) in order to determine the rôle of the cytoplasm in development. The beetle's egg consists of a large central mass of yolk surrounded by a thin superficial layer of cytoplasm. The maturation divisions take place in the cytoplasm near one side. The female pronucleus, surrounded by a small amount of cytoplasm, then moves towards the centre of the yolk-mass, forming a sort of minute island. Here the male pronucleus unites with it, and the first cleavage divisions occur. The cleavage nuclei migrate towards the periphery as they increase in number, finally fusing with the superficial layer of cytoplasm. The blastoderm of a single layer of cells is thus formed. The visible substances within a freshly laid egg are (1) the superficial layer of cytoplasm, (2) yolk-globules of various sizes, (3) the male and female pronuclei, and (4) a mass of granules near the posterior end which take part in the formation of the primordial germ-cells. These granules are called by Hegner the "germ-track determinants." When the egg is centrifuged a "grey-

* Parasitology, viii. (1916) pp. 239–43.
† Reprinted from 16th Rep. Michigan Acad. Sci., 1915, pp. 49–54 (9 figs.).

cap" appears at the heavy end of the egg. It probably consists of nutritive material.

When the yolk, grey cap material, and cytoplasm are shifted by centrifuging, no conspicuous changes result in the formation of the embryo. Even when the yolk is driven entirely to one end, the embryo develops near the opposite, lighter end independently and normally. This suggests the conclusion that the superficial layer of cytoplasm is the controlling substance, and that this cytoplasm is heterogeneous.

This view is confirmed by observations on the normal development, and by the fact that killing a portion of the cytoplasm with a hot needle results in the absence of the part of the embryo to which this cytoplasm would otherwise have given rise, although no nuclei were destroyed. It is Hegner's conviction that the large features in development—those of phylum, class and order—are controlled by the heterogeneous cytoplasm, while smaller characteristics are more under the influence of the chromatin.

**Concealment of Eggs of Potato-beetle.***—R. W. Hegner has made experiments with the eggs of *Leptinotarsa decemlineata* in order to determine if direct sunlight is injurious to the development. He found that the eggs are not retarded in their development, but that they fail to hatch. The non-hatching is probably due to partial desiccation. The chief use of the concealment is probably to keep the eggs away from the sunlight.

**Flight of Cicada.†**—Amans has made an analysis of the flight of *Cicada plebeia*. He has also shown that Cicadas, like Hymenoptera, can dispense with their hind wings. There is a reduction in the strength and in the capacity for manœuvres, but the flight remains good and the song is unaffected.

**New Thysanoptera.‡**—R. S. Bagnall describes some interesting new forms of these minute insects collected in Trinidad. The new genera, *Sedulothrips*, *Craniothrips*, and *Chirothripoides*, are established.

### δ. Arachnida.

**Genus Hæmaphysalis.§**—G. H. F. Nuttall and C. Warburton, in continuation of a monograph of the Ixodoidea, gave an account of the genus *Hæmaphysalis*. The members are Metastriata, i.e. with anal grooves embracing the anus posteriorly; they are usually of small size; the scutum is inornate and without eyes, and the female without lateral grooves: the capitulum has a sub-rectangular base; the palps are normal, short and conical, broadest near the posterior end of article 2, which (except in rare cases) projects laterally beyond the base; the

* Psyche, xxii. (1915) pp. 24-7.
† Bull. Acad. Sci. Montpellier, Nos. 7-12 (1915) pp. 183-92 (2 figs.).
‡ Journ. Linn. Soc. (Zool.) xxxii. (1915) pp. 495-507 (2 pls.).
§ A Monograph of the Ixodoidea. Part III. Ixodidæ: The Genus *Hæmaphysalis*. 1915, pp. xiii and 202 (144 figs. and 6 pls.).

sexual dimorphism is slight, the male possessing no ventral plates or shields; coxa I is never bifid; trochanter I has a blade-like dorsal retrograde process. Forty-two species are dealt with. They occur on Mammals and birds. Nuttall and L. E. Robinson add a second bibliography (32 pages) of Ixodoidea.

**New Pentastomid.***—Mary L. Hett describes from a N. African snake (*Zamenis rarigieri*) a new Pentastomid, which, apart from histological differences, is distinguished from a true *Porocephalus* in the bifid caudal extremity, the anterior mouth opening, the vesicular protuberances round the hooks, the lower degree of development in the male genital system, the unpaired vesicula seminalis lying dorsal to the gut, the correlated dorsal extension of the vasa deferentia and dorsal position of the ejaculatory ducts, the uncoiled uterus in the female, and the anterior position of the female genital aperture with correlated differences of arrangement in the uterus and vagina.

### ε. Crustacea.

**Gall-forming Crabs.**†—F. A. Potts describes the stages in the formation of the galls by *Hapalocarcinus marsupialis* Stimpson in colonies of *Pocillopora* and *Seriatopora*. A preliminary paper has been already‡ referred to. The minute male, described for the first time by the author, is found in open galls with females which have just reached maturity. The females vary in size, from very small individuals with narrow abdomen without appendages, gonads, or genital apertures, to large forms with hypertrophied abdomens forming brood-pouches laden with developing eggs. The galls correspond in development to their inhabitants.

The peculiarities of the buccal appendages and the reduction of the armature of the gizzard are interpreted on the supposition that the crabs live on the nannoplankton drawn into the galls with the respiratory current.

In *Cryptochirus coralliodytes* the male sometimes forms shallow pits, and does not inhabit the same pit as the female. The sexual dimorphism is much less marked than in another species, *C. dimorphus*. The buccal appendages and the gizzard show the same peculiarities as in *Hapalocarcinus*, and a similar feeding is probable.

**First Record of a Species of Palæmonetes in Australia.**§—W. J. Dakin describes *P. australis* sp. n., a prawn-like crustacean extremely common in many of the rivers near Perth, Western Australia. It is also found in shallow lakes on the coastal plain. It probably breeds in the early months of the dry season. This record is a noteworthy increase in the known geographical range of the genus.

* Quart. Journ. Micr. Sci., lxi. (1915) pp. 185–200 (5 figs.).
† Papers Dept. Mar. Biol. Carnegie Inst. Washington, viii. (1915) pp. 33–69 (3 pls. and 19 figs.).
‡ See this Journal, 1914, p. 350.
§ Proc. Zool. Soc., 1915, pp. 571–4 (1 pl.).

**New Isopod from British Guiana.***—W. E. Collinge describes *Calycuoniscus bodkini* g. et sp. n., a form of doubtful affinity. It is of special interest in having a series of very peculiar chitinous organs on the body segments and cephalon. Each consists of a cup-shaped organ with a tube-like body in the centre. Similar structures have been noted by Dollfus and Budde-Lund. The form of the cephalon is unusual, the eyes being very prominent and situated almost above the cup-shaped lateral bodies, whilst the median lobe is prolonged forwards and slightly downwards.

**New Terrestrial Isopods.**†—Charles Chilton establishes a new Trichoniscid genus *Notoniscus* for the two New Zealand forms which he had previously referred tentatively to the genus *Haplophthalmus*. The new genus seems near to *Haplophthalmus*, but differs in the character of eyes, which, though small, have more than one visual element, and in the fact that the first *three* segments of the pleon have the epimeral plates very small or absent. The author also describes *Haplophthalmus tasmanicus* sp. n., which differs, however, from the definition Sars gives of the genus in having eyes not simple, but composed of three ocelli, and in having the segments of the peræon not discontiguous laterally. Another new form, also based on a single specimen, is *Cubaris suteri* sp. n., easily distinguished from all other New Zealand species by the characteristic sculpturings on the dorsal surface.

**New Ascidicolous Copepods.**‡—E. Chatton and the late E. Brement have described the female of *Brementia balneolensis* g. et sp. n., parasitic on *Leptoclinum*. It is 2 mm. in length, symmetrical, vaguely cyclopiform, with two distinct regions—cephalopereion and pleon, with much reduced cephalon, with a dorsal incubatory chamber. The thoracic limbs are strongly developed. The general colour was violet, due mainly to the gonads; the gut was yellow, the tissues were uncoloured, the eye was bright red. The new genus approaches *Ophioseides*, another ascidicolous type.

Another new form is described§ from the same host, and named *Ooneides amela* g. et sp. n. Along with *Enterocola*, *Brementia* and *Haplostoma* it may be included in a new family, Ophioseididæ. It is the most deformed and degenerate of the known ascidicolous Copepods. Only the female is known. It is globular, but with the ventral surface much shorter than the dorsal. The pereion is swollen without trace of pereiopods, and includes the pleon in a ventral cavity. The incubatory chamber is dorsal. The gut is yellow-brown, the vitellus of the eggs violet-grey-brown, the egg bright red, the tissues are uncoloured. The animal lives fixed in the cloaca. A morphological discussion of the oostegites, the pterostegites and the incubatory chamber is found in a third study.‖

* Journ. Linn. Soc. (Zool.) xxxii. (1915) pp. 509–11 (1 pl.).
† Journ. Linn. Soc. (Zool.) xxxii. (1915) pp. 417–27 (2 pls.).
‡ Bull. Soc. Zool. France, xl. (1915) pp. 129–34 (2 figs.).
§ Bull. Soc. Zool. France, xl. (1915) pp. 135–43 (4 figs.).
‖ Bull. Soc. Zool. France, xl. (1915) pp. 143–55 (4 figs.).

**New Parasitic Copepod.***—W. Harold Leigh-Sharpe describes *Lernæopoda scyllicola* sp. n., the females of which occur fixed by the second maxillæ just outside the cloaca of dogfish (*Scyllium canicula*), especially on male specimens, where they may also occur on the claspers. The ends of the second maxillæ are swollen, as long as the trunk, and united to a bulla of characteristic shape. The thorax alone shows traces of segmentation. The mandibles are slender and aciculate, and the maxillipede has a slender terminal joint and a peculiar hook-like projection on the basal joint between the cushions of spines.

**New Lernæopodidæ.**†—C. B. Wilson describes no fewer than twelve new genera of these curious Copepod parasites, and gives a revision of the entire family. A very useful account is given of the general structure and development of Lernæopods. In regard to the question of the pigmy male's nutrition, it is pointed out that the adult has mandibles as large and powerful as those of the female, and a well-developed œsophagus and stomach, but apparently no mouth or anus. The stomach is lined with large gland cells, but there are no separate digestive glands. The excretory organs are exceptionally large and have well-developed ducts. The male was never found except on the female. It is unlikely that the male lives long after fastening the large spermatophores to the sexual aperture of the female. Both sexes go without food during the free-swimming period, for their mouth parts are only suited for obtaining food parasitically. During the second Copepodid stage they both suck the blood of the fish. But it is improbable that the male gets any food after he passes from the gills to the female.

**Thompsonia.**‡—F. A. Potts describes forms of this extraordinary Rhizocephalan genus, which he observed on two crabs (*Thalamita prymna* and *Actæa ruppellii*) and on an Alpheid (*Synalpheus brucei*). A preliminary paper was previously referred to.§ The parasite appears as numerous external sacs on the host. The root system is continuous throughout the body of the host, whatever the number or stage of development of the external sacs may be. Where they penetrate the appendages the roots contain fewer yolk globules, and the lacunar space is filled with germ-cells. Besides the external sacs, there are a number of terminal swellings in the tissue of the appendages. These are similar in structure to the external sacs. and become external at a subsequent moult of the host. The external sacs consist of a mantle with an external and internal cuticular investment and a visceral mass mainly occupied by the ovary. No mantle cavity is found between the mantle and visceral mass.

There is no testis, and development is probably parthenogenetic. The egg is lightly yolked, and gastrulation takes place by epibole. The Nauplius stage is omitted, the young being hatched at the Cypris stage.

* Parasitology, viii. (1916) pp. 262–73 (6 figs.).
† Proc. U.S. Nat. Museum, xlvii. (1915) pp. 565–729 (32 pls. and 15 figs.).
‡ Papers Dept. Mar. Biol. Carnegie Inst. Washington, viii. (1915) pp. 1–32 (2 pls. and 12 figs.).
§ See this Journal, 1914, p. 351.

During development the visceral mass disintegrates so that at the time of hatching the mantle contains a great number of Cypris larvæ ready to emerge. An apical perforation is made in the mantle, and on the moult of the cuticle a way is thus opened to the exterior for the larvæ.

The escape of the larvæ is contemporaneous with or soon followed by a moult of the host. The empty shells of external sacs are carried away with the cast skin, and the terminal swellings of the root system emerge as a new crop of external sacs. Development of the germ-cells in the lacunar tissue of the roots may take place *in situ* as well as in the external sacs, but it does not apparently proceed very far. The large number of external sacs in both *Thompsonia* and *Peltogaster socialis* Krüger (which is figured on *Pagurus alaskensis*) is accounted for by a process of budding from a single original larva. The genus is not primitive, but very specialized. The effect of the parasite upon the host seemed to be negligible in the specimens examined. The genus *Thylacoplethus* Coutière is synonymous with *Thompsonia* Kossmann.

## Annulata.

**Sabellidæ and Terebellidæ.***—W. C. McIntosh discusses the British Sabellidæ, which number over twenty species, besides those dredged by the 'Porcupine' and the 'Knight Errant,' and by Canon Norman off Norway and Finmark, and also the Sabellidæ and Terebellidæ collected by Dr. Whiteaves in the Gulf of St. Lawrence. His notes include descriptions of a number of new and interesting forms.

**Leech on Catfish.**†—W. Harold Leigh-Sharpe describes *Platybdella anarrhichæ* parasitic on the gills, the walls of the branchial chamber, and the pectoral region generally of the catfish, *Anarrhichas lupus*. The body is cylindrical, moderately depressed, without papillæ or respiratory vesicles, divided, though not very distinctly, into an anterior "neck" and a posterior abdomen, very transparent. It does not roll itself up when at rest. The oral sucker is cupuliform and of moderate size. The posterior sucker is obliquely affixed and very distinct. The annuli are only made out with difficulty, and the number to a typical or abdominal somite is uncertain. The testes seem to be only five pairs. The bursa is insignificant. Pigment cells are absent. A key to the Ichthyobdellidæ is given.

## Nemathelminthes.

**Structure and Position of Acuariidæ.**‡—L. G. Seurat discusses some of the characteristics of this family of Nematodes—the two lateral lips, the œsophageal papillæ inserted behind the nerve ring, and the tube-shaped cuticular ovijector. The relations of Acuariidæ to Filariidæ, Spiruridæ, and Heterakidæ are dealt with.

* Ann. Mag. Nat. Hist., xvii. (1916) pp. 1–68 (4 pls.).
† Parasitology, viii. (1916) pp. 274–93 (11 figs.).
‡ Comptes Rendus, clxii. (1916) pp. 141–3.

**Crassicauda crassicauda.***—H. A. Baylis reports the occurrence of this Nematode in Cuvier's whale (*Ziphius cavirostris*). A (fragmentary) specimen was found near the kidneys, having evidently been pulled out of the renal tubules. It seems to have been previously found in four other whales. The mouth is a narrow slit-like aperture, whose long axis runs dorso-ventrally. It is lined with very thick cuticle. On either side of the mouth there is a small rounded papilla. Laterally to this there are, towards each side of the head, three more papillæ, mastoid in shape, and but slightly raised. The general appearance of the mouth and papillæ is very Filaria-like.

## Platyhelminthes.

**Tapeworm of Ostrich.**†—F. E. Beddard describes a species of *Davainea* from *Struthio musaicus*, which is certainly not to be confounded with von Linstow's *Davainea struthionis*, but may be the same as the worm described by Parona as *Tænia struthionis*. The scolex, 1·2 mm. in diameter, has a double row of 130 hooks in all; the suckers are unarmed; the scolex and anterior part of the body abound with calcareous corpuscles, which also occur posteriorly. There is no neck. The segments of the body are not longer than broad; the ripe segments are not moniliform; the genital pores are unilateral; the cirrus-sac reaches to the nerve-cord; the dorsal excretory vessel is absent from the posterior region of the body. The ova are imbedded singly in parenchyma extending into the cortex.

**Trematode Genus Stephanochasmus.**‡—Henry S. Pratt gives a description of *Stephanochasmus casus* Linton from the rectum of two common fishes in the Gulf of Mexico—the gray snapper (*Lutianus griseus*) and the yellow tail (*Ocyurus chrysurus*). The living worm is deep red because of the blood in the capacious intestine; it bears large spines characteristic of the genus. The internal structure exhibits several novel and interesting features.

**Structure of Didymorchis.**§—W. A. Haswell describes *D. cherapsis* sp. n., a very small Rhabdocœle, not exceeding a millimetre in length, which lives in the branchial cavity of a common crayfish of Eastern Australia, *Cheraps bicarinatus*. Another species, *D. astacopsidis* sp. n., occurring in *Astacopsis serratus*, is briefly dealt with. The genus *Didymorchis* was established by Haswell in 1900 for a Rhabdocœle from the New Zealand crayfish *Paranephrops neozelanicus*; it differs from other genera in the family Dalyellidæ (formerly Derostomidæ) in the character of the excretory system and in the restriction of the cilia to the ventral surface.

These minute colourless Rhabdocœles only occur in association with crayfishes, and show certain adaptations to their special mode of life.

* Ann. Mag. Nat. Hist., xvii. (1916) pp. 144-8 (1 fig.).
† Proc. Zool. Soc. London, 1915, pp. 589-601 (6 figs.).
‡ Parasitology, viii. (1916) pp. 229-38 (1 pl.).
§ Quart. Journ. Micr. Sci. lxi. (1915) pp. 161-9 (1 pl. and 1 fig.).

They adhere tenaciously by an apparatus having the function of a sucker to the filaments of the gills or to the walls of the branchial chamber, and are thus not liable to be swept out by the respiratory current or dislodged by the movements of the podobranchs. With cilia only developed ventrally, they glide along in close contact with the substratum, so that they can instantaneously anchor themselves when any movement takes place that might displace them.

**New Terrestrial Nemertean.***—W. J. Dakin describes *Geonemertes dendyi* sp. n., from the Darling Hills, near Perth, Western Australia. The length of the mature female is about 15 mm. when crawling. The colour is brown-pink, with two dorsal and somewhat posterior longitudinal bands of chocolate-brown. The 16 or 17 eyes are in four groups. Lateral organs are well developed, opening by characteristic ciliated cephalic pits on the ventral surface at the anterior end. The mouth opens into the rhynchodæum. The sexes are distinct. The cephalic gland does not seem to be well developed. In other structures the new form agrees well with *G. australiensis*. The specimen was found under a small log.

### Echinoderma.

**Behaviour of Comatulids.**†—Hubert Lyman Clark found twenty-two Comatulids at Maër, the largest of the Murray Islands, at the northern end of the Great Barrier Reef. They exhibit complex and variable reactions, and important differences are shown in the modes of locomotion and feeding. Many Comatulids, especially the large multibrachiate species, are very sluggish, and the members of the family Comasteridæ do not swim, but only creep about by using the arms. Comatulids of the families Stephanometridæ, Mariametridæ, Colobometridæ, and Antedonidæ, although ordinarily inactive, are good swimmers, and creeping is not the usual method of locomotion. It is doubtful if, under unchanged conditions, Comatulids move about to any important extent, but it is certain that local changes can, and do, bring about considerable alteration of position and possibly real migrations.

Comatulids at Maër feed on living Algæ and some Protozoa, presumably swept in by the ciliated furrows. All are negatively phototactic. They are markedly susceptible to heat, even to an increase of 2°. They showed no response to altered salinity. Their reaction to strong solutions of magnesium sulphate is noticeably different from that of other Echinoderms. Reactions to strong alcohol or formalin are marked and well defined, and normally follow a regular sequence. Reactions to impure sea-water, presumably to the $CO_2$, are slow but sure. An excess of impurity soon produces inaction, followed by disintegration.

* Proc. Zool. Soc., 1915, pp. 557-70 (1 fig.).
† Papers Dept. Mar. Zool. Carnegie Inst. Washington, viii. (1915) pp. 99-125.

**Fauna associated with Crinoids of Tropical Reefs.***—F. A. Potts has made at Murray Island a study of the animals habitually associated with the Crinoids of a tropical coral reef, with especial reference to coloration. The commonest Crinoid, *Comanthus annulatum*, is remarkable for its extraordinary range of colour variation from very light-coloured individuals (in which white, light green, yellow and grey mingled in the colour scheme) to others which are entirely dark green or black. By far the greater proportion of the associated animals exhibit colour resemblance to the Crinoids. In species of *Synalpheus* all stages of variation are met with, according to the individual Crinoid, between a pale form with very narrow stripes of pigment, to an extreme form totally covered with dark pigment. In *Cirolana*, on the other hand, the individuals associated with even the darkest Crinoids possess only insignificant lines of pigment on the otherwise totally white body. In the latter case there is, then, no protective resemblance, although there is perhaps just a hint of its beginning. In other cases—viz. a Polychæt, an Amphipod, and *Ophiomaza* (Ophiuroid)—the animals are dark and occur upon dark-green Crinoids.

**Periproctal Plates of Discoidea cylindrica.**†—Frederick J. North describes the periproct of this exocycloid fossil Echinoid. In most of fossils of this sort the periproct is represented by an open hole, and little or nothing is known of it. In the specimen described the preservation is complete. There are nineteen plates in two cycles of nine, and with an odd pentagonal plate adjacent to the anus.

**Temperature Co-efficient for Segmentation of Arbacia.**‡—J. Loeb and M. M. Chamberlain have carried out a series of experiments on Arbacia, as a further attempt towards a physico-chemical explanation of certain groups of fluctuating variations. They show that the temperature co-efficient for the latitude of variation of the segmentation of the egg of Arbacia (i.e. the time between the segmentation of the first and last egg of a group fertilized at the same time) is practically identical with the temperature co-efficient for segmentation. The fact is intelligible on the assumption that the fluctuating variation in this case is due to a variation in the mass of enzyme contained in the different eggs, and supposed to be responsible for the rate of segmentation.

## Cœlentera.

**Remarkable Brackish-water Hydroid.**§—James Ritchie describes *Annulella gemmata* g. et sp. n. from a brackish pool at Port Canning, Lower Bengal. The generic diagnosis runs:—Polyps solitary and naked, with conical proboscis, and long, scattered, capitate tentacles

* Papers Dept. Mar. Biol. Carnegie Inst. Washington, viii. (1915) pp. 73–96 (1 pl. and 7 figs.).
† Ann. Mag. Nat. Hist., xvi. (1915) pp. 499–501 (1 fig.).
‡ Journ. Exper. Zool., xix. (1915) pp. 559–68.
§ Records Indian Museum, xi. (1915) pp. 541–71 (2 pls.).

bearing nematocyst batteries arranged in many rings, and furnished with strong multiserial endoderm. During their fixed stage the polyps are attached by an adherent base, connected to them by a narrow neck and enclosed in perisarc. Multiplication by vegetative reproduction is the rule, but there are also free medusoids.

The polyps are minute, 0·15 to 1 mm. in height; the tentacles are four to twelve in number. The living animals were colourless. The tentacles and polyp-body are furnished with two types of nematocysts (macrocnides and microcnides). The polyp is alternately fixed and free, escaping from its basal bulb by rupture of the connecting neck, and again developing a new basal bulb by a modification of its proximal end.

Reproduction is normally asexual, by means of buds set free in a planula-like stage, by means of the detached basal bulb, and possibly by means of longitudinal fission. The type of sexual phase is not known with certainty.

**Hydroid Stage of Lar sabellarum.***—James F. Gemmill has found this interesting hydroid at Tarbert, Loch Fyne. The material collected, which included some small Sabellids, was brought to Glasgow and kept under a "convection-current" circulation. Minute hydroid-like growths were observed near the open ends of two of the Sabellid tubes, and gonozoids were liberated, which were identified as the first stages of the medusoid of *Lar*. The medusoid stages have been observed in the Firth of Clyde plankton by Browne and Dick. The species, which was described by Gosse, is of unusual interest, for the hydropolyp is strikingly different from the usual gymnoblastic type, while the medusoid shows characters to some extent intermediate between the Anthomedusæ and the Leptomedusæ. Gosse gave a very lively account of the quaint mannikin-like individuals and of their grotesque bending and swaying antics round the mouth of the Sabellid tube. The most striking feature of the genus *Lar* is the possession of only two tentacles springing from one side of the base of a highly mobile bilabiate proboscis. The reproductive individuals are slender and without tentacles, and bear the gonozooids in clusters of three or four.

**Ecology of a Coral Reef.**†—Alfred Goldsborough Mayer has made an ecologual study of the fringing reef of Maër Island, the largest of the Murray Islands in the Torres Straits. The reef flat is peculiar in that the water is dammed by the Lithothamnion ridge, which extends in a narrow barrier along the seaward breaker-washed edge of the flat. Thus at low tide the water over the reef flat becomes a marine basin about two miles long, 1680 feet wide and only about eighteen inches deep The water is impounded by the Lithothamnion ridge, and the flat is never laid bare even by the lowest spring tides. About 3,600,000 living coral heads are found upon this submerged area. About forty different species and twenty-two genera are represented, but 91 p.c. of the living coral heads are referable to *Porites* (38 p.c.), *Seriatopora*

* Glasgow Naturalist, vii. (1915) pp. 1–2.
† Proc. Nat. Acad. Sci., i. (1915) pp. 211–4.

(25 p.c.), *Acropora* (18 p.c.), and *Pocillopora* (10 p.c.). For the first 370 feet out from the shore there are no corals.

In the calm waters of the middle zone of the reef flat, 1100 feet from the shore, the most successful genus is *Seriatopora*, which dominates over the others. Yet this coral cannot live within 500 feet of the shore, because of the high temperature, nor survive in places more than 1650 feet from the shore, because the breakers destroy its fragile stems. Temperature is the dominant factor, even more important than silt in determining the habitat of corals. It is probable that the high temperature causes asphyxiation. "The corals of this Australian reef, which are never subjected to cold, can nevertheless withstand low temperature quite as readily as can the corals of the 'cold devastated' reefs of Florida; and conversely the Florida corals can withstand high temperatures quite as well as do those of Australia. In other words, corals are, physiologically speaking, of similar constitution whether in the Atlantic or the Pacific; and natural selection has apparently not operated to improve their cold-withstanding or heat-resisting powers. The reef building forms must live in water which is warmer than 15° and cooler than 38° C."

All species of reef corals survive without apparent injury an immersion for four to five hours in sea water diluted with an equal volume of rain water, and many species can withstand eleven hours of this treatment. The injurious effects of torrential rains upon coral reefs is due solely to the silt which they cause to be washed outward over the flats.

**Alcyonarians and a Stylaster from West Coast of North America.*** — S. J. Hickson describes from the region of Puget Sound and north of it (1) *Stylaster norvegicus*, *Paragorgia arborea*, and *Primnoa willeyi* sp. n. (which are representatives of a circumpolar fauna); (2) *Psammogorgia teres* (which is a representative of south-coast fauna); and (3) *Clavularia moresbii* sp. n., and *Caligorgia fraseri* sp. n., which, along with the previously described sea-pen, *Osteocella septentrionalis*, may represent a common Pacific element which extends both north and south of the line between the two sub-regions.

## Protozoa.

**British Fresh-water Rhizopods.†** — G. H. Wailes has continued, with the assistance of J. Hopkinson, the work which the late James Cash left unfinished. The third volume deals with the families Euglyphina, Gromiina, and Amphistomina.

**Observations on Kerona polyporum.‡**—H. Victor-Jones observed individuals of this ciliated Infusorian wandering over *Hydra viridis* (which had fifteen tentacles) both externally and in the food-canal.

* Proc. Zool. Soc. London, 1915, pp. 541–57 (1 pl. and 5 figs.).

† The British Fresh-water Rhizopoda and Helizoa. Ray Society (1915) xxiv. and 156 pp. (pls. 33–57, figs. 111–59).

‡ Zoologist, xix. (1915) pp. 186–9 (1 fig.).

There were nine outside and three inside. When food was withheld more individuals passed into the interior. It is suggested that *Kerona* is rather a symbion than a parasite.

**Heritable Variations in Fission Rate of Stylonichia pustulata.***—A. R. Middleton has made an experimental study of the effects of selection on the fission rate within a single "clone" (pure race). His specific problem was to determine whether it was possible to obtain, by selection from the progeny of a single individual, two types that differ characteristically from each other under identical conditions, and that retain these differences from generation to generation. He found that in *S. pustulata* it was possible, by the opposite selection through more than 150 generations of small individual variations occurring among the progeny of a single individual, to produce two sets differing hereditarily in rate of fission. During selection there was a gradual increase in the average heritable difference between the two sets, showing that the effect of selection was cumulative. This result was subjected to the most rigid tests possible, by balanced selection throughout long periods, by mass culture without selection, and by reversed selection. In every case the results were corroborated. The hereditary differences induced continued through periods of balanced selection lasting longer than the periods of direct selection by which they were induced, and did not disappear save under the effects of reversed selection. These results were first reached with the progeny of a single individual multiplying asexually. They were confirmed by :—(1) Beginning anew with a single individual from this race, and (2) experiment with a wild individual quite unrelated to the first two series. In all cases the results were the same. In the third series conjugation occurred, and it was found that the hereditary differences persisted through and after conjugation. The selection of small variations such as appear within the "pure strain" is thus an effective evolutionary procedure.

**Life-history of Didinium nasutum.**†—G. W. Calkins has investigated the life-history of *Didinium nasutum*, with special reference to the problem of the significance of encystment in ciliated Protozoa. The species was chosen for its large size, its easily controlled feeding-habits, and its readiness to encyst. Individuals were placed in fresh water along with *Paramæcium*, on which the species feeds. If one *Didinium* and nine *Paramæcium* were placed together, at the end of twenty-four hours there were usually eight *Didinium* and the *Paramæcium* had disappeared. The extraordinary process of the seizure and ingestion of the *Paramæcium* is described and figured. The actively rotating carnivorous Protozoon swims vigorously through the water, making vicious jabs downwards or sideways till it hits something soft enough for its proboscis to penetrate. The whole process is apparently fortuitous, but a *Paramæcium* once hit rarely gets away. It is partially or wholly paralyzed and is speedily swallowed, the walls of the *Didinium* stretching

* Journ. Exper. Zool., xix. (1915) pp. 451–504 (17 figs.).
† Journ. Exper. Zool., xix. (1915) pp. 225–40 (1 pl. and 12 figs.).

round it like an indiarubber bag. A small *Didinium* will thus swallow a *Paramæcium* six times its size, and on several occasions one was seen to attack and swallow a conjugating pair. The walls of the captor were usually equal to surrounding the victim, but more than one individual was seen to explode as a consequence of its too hearty meal. The proboscis is a conical projection in the centre of the anterior end. It is supported by a dense layer of trichites anchored deep in the protoplasm. In the centre of the conical proboscis is a column of protoplasm somewhat denser than the rest of the endoplasm. This is the "seizing-organ" which fastens on the prey and draws it into the body of the captor. Granules liberated from the seizing-organ when it penetrates the cortex of its victim are apparently the cause of the paralysis.

The history of the race for six months is given, but details of encystment and conjugation are reserved for a later paper. The general conclusion in regard to encystment in ciliates is that it serves a threefold purpose: For protection against adverse conditions of environment, for reproduction, and for reorganization, which has to do with the internal processes of the cell. In *Didinium* there is no encystment for purposes of reproduction, but it is frequent for purposes of protection, and periodic for reorganization. In the latter case the approach of encystment can be predicted very often from the reduced activity in feeding and dividing, two to four days in advance. Fresh water added does not bring such individuals out of their cyst until at least five days have elapsed.

**Mitosis in Trichomonad Flagellates.*** — C. A. Kofoid and Olive Swezy publish the results of a long series of observations dealing with the processes of binary and multiple fission and the accompanying phenomena of mitosis in trichomonad flagellate Protozoans parasitic in the digestive tract of Vertebrates. The processes of mitosis and multiple fission are carried out during periods of great amœboid activity of these parasites in the mucus of the intestine. Mitosis is pro-mitotic with nuclear membrane intact throughout the period of division, with nuclear separation by constriction simulating amitosis. It is, however, essentially mitotic with extra-nuclear division-centres, intra-nuclear spindle fibres, and chromosome organization out of a chromatin network and skein. The chromosomes are definite in number and are differentiated in form and size, and in behaviour. The chromosomes appear to be split longitudinally prior to their arrangement in the equatorial plate, and seem to slip into an end-to-end position in this plate, or to show a transverse constriction. The extra-nuclear organelles all share in the process of mitosis. The blepharoplast from which flagella, rhizoplast, chromatic margin and basal rod, and axostyle all take their origin, contains the division-centre. It divides into two bodies which go to the two poles of the fusiform mitotic nucleus spinning out the deeply-staining extra-nuclear paradesmose (central spindle) between them. The daughter blepharoplasts may each divide in the polar position into an axial centrosome,

* Proc. Amer. Acad. Arts and Sci., lvi. (1915) pp. 290-364 (8 pls. and 7 figs.).

and an adjacent basal granule to which flagella, paradesmose, and parabasal are attached. These two granules re-unite. In its divisions the blepharoplast shows no independent mitotic phenomena. It is not a "kineto-nucleus," and its behaviour does not support the bi-nuclearity hypothesis. The anterior blepharoplasts are shared, two and one respectively, by the daughter blepharoplasts, and new outgrowths complete the complement of each daughter organism. The chromatic margin of the undulating membrane represents an intracytoplasmic posteriorly-directed flagellum. It splits longitudinally to the lip of its projecting end. The undulating membrane below it also splits. The chromatic basal rod is the homologue of the parabasal body of *Parajoenia* and the Trichonymphida as established by Janicki. The new axostyles of the daughter organisms are formed by the longitudinal splitting of the old axostyle from the anterior end. They are not formed from the central spindle as maintained by Dobell, or anew as claimed by Kuczynski. The axostyle is not primarily a skeletal structure as usually supposed, nor an organ of fixation as described by Kunstler and Kuczynski, but a locomotor organ used vigorously during the amœboid stage. During mitosis the organelles are subject to a wide variation in location. Plasmotomy is long delayed after nuclear mitosis, and during this period many widely varying positions are assumed by the two daughter nuclei. Some of these may simulate copulation. The plane of division is longitudinal.

Multiple fission occurs in the trichomonad flagellates as a normal phase of the life-cycle, and results in the formation of an 8-nucleate plasmodium or somatella. The observers have not so far been able to relate it to a particular stage such as gametogenesis, or to the divisions of a zygote. Three rapidly succeeding synchronous mitoses give rise to 2–4–8-nucleate plasmodia which are not encysted and remain very active throughout the process. The plasmodium disintegrates into its component members by the successive detachment of single merozoites. The widespread occurrence of the stage of a multinucleate plasmodium among these simple Protozoa is significant as an early step in the evolution of the more permanent multinucleate and multicellular aggregates which constitute the Metazoa.

**Pneumocystis carinii in Mice in England.*** — Annie Porter records the occurrence of this parasite in the lungs of a mouse in England. The cysts are spherical or oval and from 4 $\mu$ to 6·5 $\mu$ in diameter. Eight merozoites are finally formed within them. The organism appears to be an independent parasite of the lungs of certain Vertebrates and to be unconnected with any Trypanosome.

**Common Intestinal Protozoa of Man.†**—C. M. Wenyon gives a very useful account of Protozoa from the alimentary tract of man. Some of these are at present not uncommon in soldiers who have returned from the East. To the Rhizopods belong the definitely patho-

* Parasitology, viii. (1916) pp. 255–9 (8 figs.).
† Lancet, Nov. 27, 1915, pp. 1173–83 (1 pl.)

genic *Entamœba histolytica*, the quite harmless *E. coli*, and a small form very like *Amœba limax*, all inhabiting the large intestine and cæcum. To the group of the Mastigophora belong three common Flagellates:— (1) *Lamblia intestinalis*, from the upper part of the small intestine, with the greatest claim to being pathogenic; (2) *Tetramitus mesnili*, supposed to give rise to intestinal irritation followed by diarrhœa; and (3) *Trichomonas intestinalis*, generally regarded as harmless. The two latter Flagellates inhabit chiefly the large intestine and cæcum, and multiply actively if the intestine is deranged. Some other Flagellates, species of *Bodo*, *Cercomonas* and *Prowazekia*, each with two flagella, are less frequently met with. They occur especially in diarrhœic conditions. Several Ciliates occur, but the large *Balantidium coli*, from the large intestine, is the only common one. Pigs are generally infected with this Ciliate, which, escaping from them in the encysted condition, gains entrance to the human intestine, and by actual invasion of the wall of the large intestine gives rise to the serious condition known as balantidial dysentery. The author describes these forms, and shows how they may be most readily identified.

**Minchinia: a Haplosporidian.***—Helen L. M. Pixell-Goodrich discusses this parasite found by Lankester in 1885 in the liver of Chiton and called *Klossia chitonis*. It was afterwards referred by Labbé (1896) to a new genus *Minchinia*, and ranked among the Coccidia. The author has studied it in *Craspedochilus cinereus* from near Plymouth; it was not found in *Acanthochites* (*Chiton*) *fascicularis*, stated by Labbé to be the host at Roscoff. The genus is shown to belong to the Haplosporidia. Its life-history in Chiton consists of two stages, a trophic and a sporogonic. During the trophic stage a multinucleate individual divides by a process of plasmotomy. During the sporogonic stage a plasmodium becomes encysted and forms gametes. These fuse in pairs (autogamy ?) to form zygotes. The zygote breaks into four sporoblasts, each of which acquires an external membrane drawn out into a tail at each end, and later a thick chitinous coat immediately inside the membranous one. Crabs, blennies, and starfishes eat Chiton, but the spores of *Minchinia* pass through unchanged and are in this way disseminated. The spores do not seem to open in the gut of Chiton.

**New Myxosporidian Genus.**†—J. S. Dunkerly describes *Agarella gracilis* g. et sp. n, a myxosporidian belonging to the family Chloromyxidæ, beside *Chloromyxum*. It was found in the testis of *Lepidosiren paradoxa*, the South American lung-fish. The spores differ from those of *Chloromyxum* in being elongate, slightly flattened in the sutural plane, and in possessing a long bifid tail composed of an elongation of each spore valve posteriorly. They resemble those of *Henneguya*, but have four polar capsules—the characteristic mark of Chloromyxidæ. The steps of the process of myxosporidian spore-

* Proc. Zool. Soc., 1915, pp. 445–57 (2 pls.).
† Proc. Roy. Phys. Soc. Edinburgh, xix. (1915) pp. 213–9 (1 pl. and 1 fig.).

formation are summarised :—(1) Differentiation of the nuclei in the plasmodium into two types, small and large ; (2) formation of protoplasm around these nuclei into two types of cell, small with small nucleus (microcytes), and large with large nucleus (megalocytes) ; (3) union of micro- and megalocyte to form the binucleate sporoblast ; (4) union and fusion of two sporoblasts to form the four-nucleate pansporoblast ; and (5) division of the two megalocyte nuclei to form twelve nuclei (sixteen in forms with four polar capsules), while the two microcyte nuclei apparently remain as the two pansporoblast nuclei.

**Possibility of Milk being infected with Trypanosomes.***—A. Lanfranchi made experiments on pregnant animals by injecting them with several kinds of trypanosomes, and came to the conclusion that *Trypanosoma brucei*, *T. rodiense* and *T. gambiense* could pass into the milk, and that in the case of *T. brucei* and *T. gambiense* the infection could pass to the offspring.

**Activity of Soil Protozoa.**†—George P. Koch gives the results of experiments on Protozoa which exist in the soil usually as cysts, but become excysted with a certain amount of moisture, and in their active state are believed to be destructive to bacteria. He has found that the most satisfactory method of determining the presence of motile Protozoa is to place on a clean slide a few drops of sterile tap-water, and stir in it, to form a thin film, a small portion of soil, at once examining it under the Microscope, for not more than two minutes, on account of the rapid excystment of the Protozoa. He finds that small ciliates, flagellates and amœbæ are active in some greenhouse soils, but only occur in small numbers ; that they are not present in field soils normally moist, though all such soils contain cysts, the organisms of which become active with further moisture, while temperature, organic matter and physical properties of the soil are only secondary factors ; that active Protozoa are always present in water-logged soils and in free standing soil-water ; that after heavy rain some Protozoa excyst and remain active so long as the soil is sufficiently wet ; and that under normal conditions Protozoa cannot excyst in 2 minutes, small ciliates doing so in 1 to 2 hours, flagellates in 6 to 8 hours, and large ciliates in 40 hours, all at a temperature of 22° to 24° C. Excystment probably goes on more rapidly at higher temperatures, and the original moisture-content of the soil may also affect the length of time, while different types of Protozoa may prefer different conditions. Further study on this point will be made.

**Leucocytozoon in Ducks.**‡—A. B. Wickware describes what seems to be a new disease in ducks (in Ontario). The birds show impaired appetite and stupor. When roused they display great excitement and locomotor disorders. The mortality was very high. An examina-

* Atti R. Accad. Lincei, xxv. (1916) pp. 369–73.
† Journ. Agric. Research, v. (1915) pp. 477–88.
‡ Parasitology, viii. (1915) pp. 17–21 (3 pls.).

tion of the blood showed in the peripheral circulation the presence of large numbers of a species of *Leucocytozoon*, which the author names *L. anatis*, sp. n. This form is not present in the blood of healthy ducks. As transmission experiments did not succeed, it is not proved that the parasite causes the disease. The predominant type is a spindle-shaped organism, 35 $\mu$ to 60 $\mu$ in length by 10 $\mu$ in width, showing an oval elongated or irregularly shaped nucleus, with a dark chromatic band along one border. In the centre may be observed a small chromatin-staining body.

# BOTANY.

## GENERAL,

### Including the Anatomy and Physiology of Seed Plants.

### Structure and Development.

#### Reproductive.

**Ovary of Ephedra.***—O. Lignier and Adr. Toison contribute a note dealing with the ovary and ovule of *Ephedra*. The authors find that the flower is of the angiospermic type, and has a terminal, tetracarpellary, unilocular ovary with a style and basal placentation. In the lower part of the ovary is "a single upright ovule apparently reduced to the nucellus." The fibro-vascular system of the ovule is composed of (1) placental bundles similar to those found in the base of an angiospermic ovary having basal placentation; (2) funicular and chalazal branches similar to those which spread over the base of the ovules of angiosperms. Rudimentary vestiges of the integuments can also be traced around the base of the nucellus. The latter has a pollen-chamber, and secretes an attractive fluid which penetrates into the style and issues out at the stigma. The present work, taken in connexion with that done on *Welwitschia*, leads the authors to conclude that these two genera are very primitive and specialized angiosperms, which have preserved some distinct gymnospermic characters.

**Embryology of the Cruciferæ.**†—R. Souèges has studied the development of the embryo of the Cruciferæ in order to clear up some points which have not yet been satisfactorily explained. The author has studied *Lepidium sativum*, *L. campestre*, *L. Draba*, and *Cochlearia officinalis*, and finds that the process of development is similar in all four species. The apical cell of the pro-embryo gives rise to the embryo, while from the upper suspensor-cell is formed the hypophysis, which in turn furnishes the initial-cells of the cortex and the greater part of the root-cap. The quadrants are formed in two stages; by their transverse division they become separated into a cotyledonary and a hypocotyledonary region, each composed of four octants. In both regions the epidermis is first differentiated by a wall parallel to the surface. In the lower octant the cortex is developed subsequent to the formation of two rectangular walls, formed at right angles to those of the meridian; three cells are thus formed, the central of which gives rise to the plerome, and the remaining two to the periblem. In the

* Comptes Rendus, clxii. (1916) pp. 79-81.
† Ann. Sci. Nat. Bot., xix. (1914) pp. 311-39 (73 figs.).

upper octant the first divisions of the sub-epidermal cell closely resemble those observed in *Myosurus minimus*: the subsequent fate of the resulting cells is uncertain, but they appear to represent part of two tetrads of initial-cells of the cortex and tissue between the latter and the dermatogen; it is from this region that the two cotyledons take their origin.

A comparison of the embryology of the Ranunculaceæ and the Cruciferæ shows that the former is the more primitive, being characterized by extreme simplicity and regularity of division, while the latter shows more tendency to adaptation and to processes tending to acceleration of the various phenomena of development.

## CRYPTOGAMS.

### Pteridophyta.

(By A. Gepp, M.A., F.L.S.)

**Sorus and Prothallus of Peranema.***—R. C. Davie describes the development of the sorus and sporangium and the prothallus of *Peranema cyatheoides* D. Don. 1. The sorus arises superficially on the under side of the leaf; it has a basal indusium of cup-type, with one portion of the cup suppressed in development, and the other over-arching the receptacle and becoming contracted at its rim; the receptacle is of the Gradate type; the central part of the stalk of the sorus is continuous with the receptacle, and the peripheral part is continuous with the indusium. 2. The early sporangia arise in basipetal sequence; the mature sorus is a mixed one. 3. The sporangium in its early segmentation sometimes follows the Cyatheaceous type, sometimes the type of the Polypodiaceæ. 4. The prothallus bears glandular hairs, sometimes slightly raised above the level of the surface upon unicellular bases; the antheridium has been found in every case but one to have an undivided lid-cell. 5. On a general comparison of the features of *Peranema* and the closely related genera in the Woodsieæ-Woodsiinæ group of Polypodiaceæ, the following grouping is suggested:—*Woodsia*—*Diacalpe*—*Peranema*. *Woodsia* comes nearest to the Cyatheaceæ, *Peranema* to the Polypodiaceæ. 6. The mature sorus of *Peranema* is held to be related to that of *Nephrodium*, and a phyletic line is traced from the Cyatheaceæ to the Aspidieæ group of Polypodiaceæ.

**Wound Reactions in Petioles of Pteris aquilina.**†—H. S. Holden publishes some observations on the wound reactions of the petioles of *Pteris aquilina*. 1. Petioles of wild *Pteris aquilina* often show wound-scars. The majority of the wounds are very superficial, not penetrating the sub-epidermal sclerenchyma; others are deeper seated. 2. The wound reactions are somewhat variable, but are characterized by (i) a compensatory local thickening, and partial or complete lignification of

* Ann. Bot., xxx. (1916) pp. 101–10 (1 pl. and 3 figs.).
† Ann. Bot., xxx. (1916) pp. 127–34 (4 figs.).

the cortical parenchyma, which may or may not be accompanied by elongation, (ii) the local delignification of the sub-epidermal sclerenchyma, (iii) a deposit of tannin in the cell-walls in the affected area. 3. Wound reactions in the tissues composing the vascular strands are rare, and where they do occur are confined to the starch sheath and conjunctive parenchyma, which thicken and may elongate and divide. 4. The results obtained are confirmatory of those produced experimentally.

**Pteris quadriaurita and its Allies.***—G. Hieronymus gives an account of *Pteris quadriaurita* and nineteen of its allies from the Asiatic, Malayan and Polynesian regions, with long and detailed descriptions of the species and critical remarks. Eleven of the species are new, and much care is taken to clear away the confusion that has prevailed in the past concerning the members of the group.

## Bryophyta.

(By A. Gepp.)

**Gemmæ of Pterigynandrum filiforme.**†—C. Warnstorf publishes a note on the vegetative propagation of *Pterigynandrum filiforme*. In 1905 he notified that he had observed easily detachable branchlets ("brutästchen") which presumably serve as a means of propagating the species; and further that he had seen pyriform gemmæ ("brutkörper") which he believed to belong to the same species. He has never seen these "brutästchen" again; but he is in a position to confirm the occurrence of "brutkörper" in the species; and he describes and figures them as oblong to clavate rows of two to four cells, brown, with the basal cell hyaline, and borne at the tips of short small fascicles of branches, arising in the axils of the leaves.

**Cratoneuron filicinum.**‡—L. Dietzow discusses in some detail the disputed systematic position of *Cratoneuron filicinum*. Described as *Hypnum* by Linnæus, it has in recent times been referred by Roth, Loeske and Warnstorf to *Cratoneuron*, and by Loeske and Brotherus to *Hygroamblystegium*. In 1911 Mönkemeyer replaced it in *Cratoneuron*, by reason of its stout leaf-structure, its paraphyllia, etc., and insists upon its great variability; further he showed, in opposition to Limpricht, that it does have plicate leaves and that it may have weakly papillate cells (which Limpricht believed to occur only in *C. decipiens*). The present author confirms Mönkemeyer in these details, and describes a very papillose specimen from a sun-baked situation in East Prussia. The function of the papillæ he explains as being to protect the cell-contents from excessive sunlight. All the varying papillate forms he groups under the one variety *verrucosa*, with two extreme forms *scabrida* and *pseudopapillosa*.

* Hedwigia, lv. (1914) pp. 325–75.
† Hedwigia, lv. (1914) pp. 378–80.
‡ Hedwigia, lv. (1914) pp. 277–9.

**Cryphæaceæ of C. Müller's Herbarium.***—M. Fleischer publishes a critical revision of some of the genera in Carl Müller's moss-herbarium at Berlin, especially in the family Cryphæaceæ. Müller too often disregarded the work of his contemporaries Mitten and Schimper. Fleischer arranges in parallel columns the species names represented in Müller's herbarium, and the correct names to be maintained at the present day. Seventy-two species of *Cryphæa* were recognized by Müller, some of them unpublished. These and their present-day names, with annotations, are set out by Fleischer in parallel columns, with the result that several (twenty-seven) of them pass into eight other genera, principally *Acrocryphæa*; and two new genera, *Sphærotheciella* and *Cryphæophilum*, are created by Fleischer from the types *Cryphæa sphærocarpa* and *C. mollis* respectively; also *Cyptodon* Paris and Schimper is revived as a genus of Cryphæaceæ. Treated in like fashion, five of the nine species of *Dendropogon* in Müller's herbarium pass into *Cyptodon*.

**North American Hepaticæ.**†—A. W. Evans publishes his sixth chapter of notes on North American Hepaticæ, including two species new to science—*Jamesoniella heterostipa* and *Cololejeunea tuberculata*, and three which are additions to the United States flora—*Aphanolejeunea sicæfolia* Evans in Florida (West Indian), *Frullania mexicana* Lindenb. in Arizona (Mexican), *F. riojaneirensis* Spruce (South American). The structure and morphology of the two new species is described and figured. *Jamesoniella heterostipa*, found in Nova Scotia, is closely related to *J. autumnalis*; but, as the latter is an anomalous member of *Jamsoniella*, in respect of its habit, branching, cell-structure and underleaves, it is quite a question whether it would not better be placed in a new genus. *Cololejeunea tuberculata*, found in Florida, is remarkable for the roughness of its leaves and perianth. *Frullania mexicana* Lindenb. is very closely allied to *F. Rappii* Evans, found in Florida in 1913; it belongs to the sub-genus *Trachycolea*; details of its structure are given.

**Hepaticæ of New Mexico.**‡—P. C. Standley publishes a list of seven Hepaticæ, the first ever recorded for New Mexico—a state which by its arid climate is so unsuited to the requirements of hepatic life. It is only high on the mountains that these plants have been observed:—*Plagiochasma rupestre*, *Reboulia hemisphærica*, *Conocephalum conicum*, *Marchantia polymorpha*, *Chiloscyphus rivularis*, *Porella platyphylla*, *Frullania Brittoniæ*. The first-mentioned species occurs also in Arizona, but nowhere else in the United States.

**Bucegia.**§—C. C. Haynes publishes figures of *Bucegia romanica*, collected in British Columbia by A. H. Brinkman, and previously known

* Hedwigia, lv. (1914) pp. 280–5.
† Bryologist, xviii. (1915) pp. 81–91 (1 pl. and figs.).
‡ Bryologist, xviii. (1915) pp. 91–3.
§ Bryologist, xviii. (1915) pp. 93–4 (figs.).

only from the Carpathian Mountains of Roumania. It is a remarkable thalloid hepatic allied to *Preissia quadrata*.

**South American Bryophyta.***—E. Irmscher gives an account of the Bryophyta collected in Columbia by E. Mayor, namely, fifty-two mosses, two sphagna and nineteen hepatics, among which were nine new mosses, described by Irmscher and Brotherus. The sphagna and hepatics were submitted to Warnstorf and Stephani respectively.

**African Mosses.**†—H. N. Dixon publishes a list of thirty-one African mosses, partly from the herbarium of the late W. Mitten, partly from H. A. Wager and other collectors. Most of the specimens were gathered in the Transvaal, others in Cape Colony, tropical East Africa, Mauritius, Angola, Congo. *Lindbergia* is a genus founded on a North American species by Kindberg; Brotherus added a few species from Asia, Abyssinia, United States; Dixon now adds two more from South Africa, which much resemble *Pseudoleskea* and *Haplocladium* in habit, but distinguished by the erect symmetrical capsule and by the peristome characteristic of *Lindbergia*—the absence of processes on the inner peristome, the densely papillose outer teeth, and the large spores. In all, the author describes and figures ten new species and intercalates many critical notes.

**Mosses of Lord Howe Island.**‡—V. F. Brotherus and W. W. Watts give a list of the mosses collected by Watts on Norfolk Island in 1911, mostly on the twin mountains, Lidgbird and Gower, and in the deep Erskine Valley between them, that is, at the south end of the island. More than ninety species were collected, and twenty-two of these and a few varieties are described, as being new to science. In an appendix the works of previous authors on the bryology of the island are cited, and lists of their new species are given.

**Mosses of New Guinea.**§—M. Fleischer reports on the mosses collected by the Dutch scientific expedition to New Guinea, namely, by A. C. de Kock in 1911 and by R. F. Janowsky in 1912. He describes and figures eight new species, one of which (*Brotherobryum Dekockii*) is the type of a new genus. A remarkable fact is the wide distribution of *Schlotheimia* in the central mountains of New Guinea; for this genus has its centre in the Andes of South America; and Fleischer concludes that there a great land-mass must have existed between these two regions. An interesting discovery is that the dwarf male plants of *Schlotheimia Koningsbergeri* germinate in the old fruit-capsules and develop there to full maturity. A number of critical remarks add to the value of the systematic part of the paper.

* Mém. Soc. Neuchâteloise Sci. Nat., v. (1914) pp. 994–1102 (2 pls.).
† Bull. Torrey Bot. Club, xliii. (1916) pp. 63–81 (1 pl.).
‡ Proc. Linn. Soc. N.S. Wales, xl. (1915) pp. 363–85.
§ Nova Guinea, Résult. exped. sci. Néerlandaise, xii. Livr. 2. Leiden: Brill, 1914, pp. 109–28 (6 pls.).

## Thallophyta.

### Algæ.

(By Mrs. E. S. Gepp.)

**Dysmorphococcus variabilis.***—H. Takeda gives a description and figures of *Dysmorphococcus variabilis*, a new genus and species of unicellular flagellate algæ belonging to the Phacoteæ, a sub-family of the Volvocaceæ. It was collected with a number of other algæ in a small pond in Richmond Park. The cell floats free, the protoplast is pyriform, and bears a pair of equal flagella nearly twice the length of the protoplast; it lives free within a hard, brittle, brown spherical shell pierced with two apertures for the flagella. The chromatophore is single, green, urceolate; the stigma small, parietal; the nucleus almost central. Propagation unknown.

**Scourfieldia cordiformis.**†—H. Takeda describes and figures *Scourfieldia cordiformis*, a new Chlamydomonad from a *Sphagnum* marsh at Keston, Kent. It differs from *S. complanata* in having an obovate side profile. It is very small, heart-shaped in front view, slightly emarginate at apex and provided with two long flagella four times the length of the cell; the chromatophore is single, green, homogeneous, and subcampanulate; stigma and vacuoles absent; nucleus minute and central. The genus *Scourfieldia* is remarkable among the Chlamydomonads for its normal movement backwards, that is, with the flagella behind it. In *Carteria* and *Chlorogonium* a temporary backward movement is sometimes observed, as also in *Trachelomonas*, a genus of Eugleninеæ.

**New Genus of Volvocaceæ.**‡—W. R. Shaw describes a new genus, *Besseyosphæra*, on a species described by J. H. Powers as "a second form of *Volvox*." § Its position is intermediate between *Pleodorina* and *Volvox*. From *Pleodorina* it is distinguished chiefly by having the gonidia scattered among the vegetative cells, instead of being developed from all the cells of the reproductive area. It differs from typical *Volvox* in having no protoplasmic connexions between the cells, and in the lateness of the first visible differentiation of the gonidia, which does not appear till after birth. The author suggests that certain species of "*Volvox*" collected in the Philippine Islands may be properly removed from that genus, and that one or more of these may be proved to belong to his new genus, *Besseyosphæra*. Diagnoses of genus and species, *B. Powersi*, are given.

**Plankton-epibiontæ.**||—B. Schröder discusses the group of plankton-epibiontæ described by various authors and himself. They are the

* Ann. Bot., xxx. (1916) pp. 151-6 (figs.).
† Ann. Bot., xxx. (1916) pp. 157-9 (figs.).
‡ Bot. Gaz., lxi. (1916) pp. 253-4.
§ Trans. Amer. Micr. Soc., xxvii. (1907) pp. 123-49.
|| Biol. Centralbl., xxxiv. (1914) pp. 328-34. See also Hedwigia, lv. (1914) Beibl., p. 92.

organisms which live on plankton, and may be termed ectoparasites or epiplankton. He describes especially the case of *Synedra investiens* W. Smith, which lives on the bristles and hairs of *Diaixys pygmæa.* A list is given of epibiontic species, with their hosts, numbering ninety in all, partly marine, partly freshwater. Chytridiaceæ, Flagellatæ and Infusoria are the most frequent, Bacillariaceæ and Peridiniaceæ less so. Of the host-plants, Schizophyceæ and Bacillariaceæ are more numerous than Chlorophyceæ and Peridiniaceæ.

**Atlas of Diatomaceæ.***—A. Schmidt's Atlas of Diatomaceæ is continued by F. Hustedt after the death of A. Schmidt and of F. Fricke. In former numbers the group of Centricæ was figured, and Raphideæ of the Pennatæ group. Now come *Eunotia*, *Fragilaria*, *Synedra*, *Nitzschia*, *Grammatophora*, *Denticula*, and of marine species, *Chætoceras*, *Rhizosolenia*, etc. A text for the atlas is also to be brought out.

**Distribution of Cyanophyceæ in Soils.**†—F. Esmarch has made a study of the distribution of Cyanophyceæ on and in various soils. The two problems he sets out to solve are: 1. Is the distribution of the earth-inhabiting Cyanophyceæ dependent on the nature of the soil? Are they commoner on cultivated (manured) land than on uncultivated? 2. Is the occurrence of Cyanophyceæ in the lower strata of soil limited to ploughed lands, or is it universally distributed? How can it be explained? The author describes his methods of work, the nature of the various soils examined, and gives tables of the species recorded. As a result he finds that as regards his first problem two factors are of the greatest importance. One is the moisture-retaining capacity of the soil. The other is the presence of nutritive solutions in the soil. Thus on one and the same soil the frequency of the Cyanophyceæ varies at different times according to these two conditions.

As regards the second problem, the author describes his material and gives lists of the species found. He then discusses the occurrence of Cyanophyceæ at depths of 10–25 c.cm. and even at 40–50 c.cm., and explains how they come there and how they support life. He describes his own experiments of burying certain species under 1 cm. of earth and keeping them in the dark for a certain length of time. The effect on the algæ is described. As regards the second question—the algæ found in the earth are conspecific with those found on the surface; and their occurrence in the lower strata is entirely due to their being carried down by the agency of animals, infiltration of water, etc. Finally, the author gives a systematic synopsis of the algæ observed, with some descriptive notes. A few undetermined species are fully described and figured.

**Blanket-algæ of Fresh-water Pools.**‡—E. L. Platt has studied the community of life that is bound up with the floating masses of filamentous algæ, known as "blanket-algæ." She describes the method

* Atlas der Diatomaceenkunde, Heft 73-9, taf. 289-316. Leipzig: O. R. Reisland, 1913-14. See also Hedwigia, lv. (1914) Beibl., p. 93.
† Hedwigia, lv. (1914) pp. 224-73 (figs.).
‡ Amer. Nat., xlix. (1915) pp. 752-62.

of collecting, and the location and character of the pools. Notwithstanding variety of seasonal conditions and the character of the pools, she found *Spirogyra* almost uniformly present, the most frequent species being *S. varians*. Fourteen other species were found less frequently. *Mougeotia* and *Zygnema* were associated with the *Spirogyra*. *Oscillatoria* occurred constantly, but in small quantities. There seemed to be no relation between the genera of algæ produced and the character and location of the pools. Diatomaceæ were invariably present, especially *Navicula*, *Synedra*, *Cocconema* and *Gomphonema*. Fourteen other genera were also recorded. Other algæ were best represented by *Closterium*, *Dictyosphærium*, and *Dinobryon*. In autumn and early winter *Vaucheria* was usually present, but only appeared twice in the spring. *Pandorina* and *Peridinium* appeared late in the year. *Oscillatoria* appeared first in March and was constant thereafter. Diatom-production was at its height in April and May at water temperature varying between 8° and 16° C., and declined markedly in June. The desmids appeared in June, with a temperature between 15° and 20° C. The proportion of *Dinobryon* increased in the latter portion of June. As regards reproduction, *Spirogyra* was found conjugating in October, April and June; *Mougeotia* in November, December, May and June. Young sessile plants of *Ulothrix* were seen in April and May. In some of the pools the blanket-algæ did not reappear till May.

**Algæ of the Komotau-Udwitz Lakes.***—J. Greger reports on the algæ of the Komotau-Udwitz group of lakes in Bohemia, six in all. From five of these were recorded altogether 35 Schizophyceæ, 6 Heterokontæ, 66 Chlorophyceæ, 58 Conjugatæ, 43 Diatomaceæ. In the sixth, the Alaun-see, the flora was small, mostly consisting of diatoms. Many of the records are new for Bohemia.

**Fresh-water Algæ of New South Wales.**†—G. I. Playfair publishes an account of the fresh-water algæ of the Lismore district, New South Wales. In a former paper he gave an account of the fresh-water algæ of the Richmond river at Lismore. The present paper deals with forms found on land. The majority were collected in 1914 from lagoons, swamps, rain-water pools, and roadside ditches, almost entirely within the boundaries of the city of Lismore. The total number of species collected on land is 273, as against 286 from the river. With certain additions for the district, the total reaches 481 species collected within a diameter of two miles. The author finds the same extraordinary dearth of Protococcaceæ in the swamps and lagoons as in the river system. The Volvocaceæ are well represented and plentiful, indeed the predominance of the green flagellates is characteristic of the district. The absence of *Dinobryon* is noticeable. A new large flagellate, *Tessella*, is described, resembling *Volvox*, but corresponding in structure and characteristics more to *Volvulina*. The Desmideæ number 156 for

* Lotos, lxii. (1914) pp. 115-23. See also Hedwigia, lv. (1914) Beibl. p. 88.
† Proc. Linn. N.S. Wales, xl. (1915) pp. 310-62.

the whole district, including the river, but in no case were they found in abundance. Those found in the river were almost entirely different from those found on land. The swamp waters were poor in Diatomaceæ, the river rich. Two new genera and 17 new species are described in the paper.

**Extreme Terrestrial Form of Zygnema.***—F. E. Fritsch describes the morphology and ecology of an extreme terrestrial form of *Zygnema* (*Zygogonium*) *ericetorum* (Kütz.) Hansg., which owes its peculiarities to its very inhospitable habitat on Hindhead Common. The mature cell contains two chloroplasts. After cell-division the daughter-cells contain a single chloroplast for a time. Division is performed by a gradual infolding of the innermost layer of the cell-wall, but is left incomplete for a time, the daughter-protoplasts being still connected through a central pore. Two or three layers are distinguishable in the longitudinal walls. The Hindhead plant remains permanently in the akinete condition. The outer portion of the wall is strongly thickened and mucilaginous, and plays a great part in protecting the cells during drought and in promoting a rapid recovery afterwards. At the beginning of a drought the fat-globules in the cell move to the periphery and form a very dense layer upon the inner face of the cell-walls. Some hours after moistening the dry plant the fat-globules have become dispersed again. At the beginning of a drought the protoplasts round off slightly and develop a new layer of membrane. Each cell divides at the most but twice between two successive periods of drought. Another method of akinete formation has been noticed early in the year; there is an unequal cell-division, resulting in the formation of an akinete and of a much smaller pigment-cell. The contents of the pigment-cells subsequently disappear, and the empty cells form weak points, where the filament readily ruptures.

**Structure and Origin of Cladophora Balls.**†—Elizabeth Acton gives an account of the structure and origin of *Cladophora* balls, such as are found in certain lakes of Scotland and Ireland, and in other parts of Europe. Papers have been published by F. Brand, C. Wesenberg-Lund and others on the subject. The species which constitute the balls belong to the sub-genus *Ægagropila*. The balls found in Loch Kildona, S. Uist, consist of *C. holsatica* Kütz. They are composed of a densely felted thin living outer-sphere surrounding a large cavity filled with plant-debris and mud. The individuals composing the outer-sphere, having lost their apical cells by attrition, emit many lateral branches, some of which have been called "rhizoids" and others "cirrhoids," which act respectively as haptera and clasping tendrils thus firmly interlocking the feltwork of plants; other branches are "stolons" and act as agents of propagation. Multiplication takes place only in vegetative ways, as the main cells slowly die off behind and set the branches free. Sometimes isolated old axial cells rejuvenate

* Ann. Bot., xxx. (1916) pp. 135-49 (3 figs.).
† New Phytologist, xv. (1916) pp. 1–10 (figs.).

in favourable conditions, put out branches and initiate a new plant. Very thick-walled hypnospores have been observed in the old balls which had been in a laboratory for eight years; they burst or cast off the thick wall and put out a long "rhizoid," into which some of their protoplast passes. The origin of the balls is described by Wesenberg-Lund to be as follows:—A shallow part of the lake has its floor clothed with a layer of small tufted separate individuals, which, during the undulations set up by strong winds, hook on to one another and gradually form packets, which again, being rolled by waves and rubbed against the sandy floor, become rounded, and, losing their apical cells, actively produce lateral branches which bind them together the more firmly. Dying off in the centre, the balls tend to become hollow, and in April and May contain enough gas within to raise them to the surface. At other times of the year the plankton of the waters provide a screen dense enough to prevent full light from penetrating the waters; and the balls are unable to rise to the surface.

**Development of the Conceptacle in Fucus.***—M. L. Roe has re-investigated the development of the conceptacle in *Fucus*, and comes to the following conclusions:—1. The conceptacle originates as a slightly modified continuation of the external layer of the thallus, being segments of the apical cell whose basal portions are constantly meristematic and never entirely breaking down. 2. The hairpit is a juvenile stage of the conceptacle, the sex organs appearing in the same cavity as the mature hairs, but after their loss. 3. A distinct phylogenetic series is seen in advance from continuous patches of hairs and reproductive bodies, to scattered sori, to scattered conceptacles, and finally to apically placed conceptacles or to conceptacles on specially developed side branches. All of these structures originate through modification of the superficial layer of the thallus.

**Undaria and its Species.**†—Under this title K. Okamura discusses three closely related Japanese species: *Undaria pinnatifida* Sur., *Hirome undarioides* Yendo, and *Laminaria Peterseniana* Kjellm. He quotes first the original descriptions of each species, adding further details of his own observation. Then he compares each with the other two, and shows that there is an evident gradation from one to the others. Thus by extending the genus *Undaria* in certain particulars he is able to unite all three species in the one genus. The difference in the sori are shown to be few and relatively subordinate. The chief characters in common are: the winged state of ancipitous stem, the lack of mucilaginous lacunæ, the presence of cryptostomata, the characteristic mucilaginous glands, and paraphyses capped with a mucilaginous mass. The extreme forms are *U. Peterseniana* and *U. pinnatifida* var. *distans*, and these are connected by *U. undarioides*. The affinities and distribution are discussed.

* Bot. Gaz., lxi. (1916) pp. 231–46 (4 pls.).
† Bot. Mag. Tokyo, xxix. (1915) pp. 266–78 (1 pl.).

**Scinaia furcellata.***—N. Svedelius publishes an account of the cytological development of *Scinaia furcellata* as a contribution to the subject of reduction-division of the non-tetrasporiferous Florideæ. He describes the vegetative structure, the monospores, the spermatia, the cystocarp with the anomalies of its development, and compares the alternation of generations in *Scinaia* and *Polysiphonia*—the haplobiontic and the diplobiontic Florideæ. He summarizes his work as follows :— A study of the development of the epidermal tissue of *S. furcellata* shows that the cells, full of protoplasm, which lie between the empty epidermal cells and have been regarded as assimilation cells, are in reality stalk-cells either for monosporangia, or for spermatangia, or for hairs. Only after these growths have fallen off do the stalk-cells possibly become transferred into empty epidermal cells.

Monosporangia occur on monœcious individuals of *Scinaia* of much the same structure and appearance as in other Nemalineæ, e.g. *Batrachospermum*. One or two arise from the same stalk-cell. Subsequent growth through a sporangium is common ; the chromosome number of the monospore is approximately ten.

The spermatangium mother-cells of *Scinaia* appear several together in branched groups from the same stalk-cell. The spermatium nucleus has ten chromosomes.

The three-celled carpogonial branch forms, from the upper first cell, the carpogonium and trichogyne, with its special nucleus. From the hypogynous second cell arise, before fertilization, four auxiliary cells with rich protoplasmic contents. From the lowest or third cell of the carpogonial branch arise the cells which form the covering or wall of the cystocarp after fertilization. The nuclei of the carpogonial branch, including the egg-nucleus, have ten chromosomes. After fertilization the diploid nucleus, which now has twenty chromosomes, moves into one of the auxiliary cells, which fuse more or less with one another. This procedure has been recorded in Gelidiaceæ, but not hitherto in Chætangiaceæ. The first division of the diploid nucleus is a reduction, preceded by a short spirem stage and a distinct diakinesis with ten double chromosomes. As a result there arise four nuclei. From one only of these is developed the gonimoblast, which grows out from the auxiliary cell into the empty carpogonium again, from which later the gonimoblast branches grow out one-sidedly. The nuclei of the young gonimoblast filaments have ten chromosomes.

The wall of the cystocarp arises exclusively from the basal third cell of the carpogonial branch. The cell mentioned by Setchell as bearing the cystocarp is not formed from the carpogonial branch itself, but from the cell in the intermediate tissue of the *Scinaia* thallus which bore the carpogonial branch. The carpospores are cut off successively, 2–3–4 at a time. Some of the gonimoblast branches remain sterile and form a sort of long paraphysis. The number of the chromosomes in the carpospore nucleus is ten. *Scinaia* (and possibly *Nemalion*) represents a special type of alternation of generations among the Florideæ, the distinguishing mark of which is that the first division of the diploid nucleus

* Nov. Act. R. Soc. Sci. Upsala, ser. 4, iv. No. 4 (1915) 55 pp. (figs. in text).

is a reduction-division. All individuals are therefore alike, monœcious haploid sexual plants with monosporangia. Tetraspores are entirely wanting. Carpospores of this stage are haploid. Florideæ of this type are here called haplobiontic Florideæ (*Scinaia*, *Nemalion* ?), in contradistinction to the diplobiontic Florideæ (*Polysiphonia*, *Griffithsia*, *Delesseria*, *Nitophyllum*, *Rhodomela*), which have haploid sexual individuals and diploid tetrasporic ones. The carpospores in this stage are diploid. The author gives his reasons for considering the haplobiontic type as older than the diplobiontic.

**Oceanic Algology.***—A. Mazza, continuing his study of the family Dumontiaceæ, describes the structure and morphology of the following genera:—*Weeksia* (2 species), *Dilsea* (2), *Constantinea* (3); and, passing on to the Nemastomaceæ, describes *Calosiphonia* (2 species), *Platoma* (3), *Schizymenia* (4). In addition to the account of the vegetative structure of the holdfast, stipes, frond, prolifications, &c., notes on the reproductive organs are given.

**Marine Algæ of the Caroline and Marianne Islands.**†—K. Okamura publishes a list of species from these islands, consisting of 28 species of Chlorophyceæ, 11 Phæophyceæ, and 22 Rhodophyceæ; among which are 3 new species, *Dilophus repens*, *Haliseris repens*, and *Halarachnion calcareum*. The latter is the only species of the genus known to be impregnated with lime in the inner tissue of the frond. The geographical distribution shows that a great resemblance exists between the marine flora of the Caroline Islands and that of the Indian Ocean and the Malay Archipelago, as well as that of Ryukyu.

**Marine Algæ of Chosen.**‡—K. Okamura publishes a list of the marine algæ of Chosen, in which he records 102 species, including a new species of *Ecklonia*, *E. stolonifera*. When the plant is quite simple it is difficult to distinguish from *Laminaria* but for the marginal teeth which are characteristic of *Ecklonia*. Later it develops the usual lateral branches or lobes and net-like rugosities. The primary frond decays down during the autumn, more or less toward the base of the lamina; and a new lamina grows up during the winter replacing that of the previous year, in the manner of *Laminaria Cloustoni*. The author discusses the variety of temperature along the coast, due to cold and warm currents, and its effect on the distribution of the algæ.

* La Nuova Notarisia, xxvii. (1916) pp. 1–53.
† Bot. Mag. Tokyo, xxx. (1915) pp. 1–14 (1 pl.).
‡ Rep. Imp. Bureau Fisheries, Tokyo, Sci. Invest., ii. (1913) pp. 17–30 (1 pl.).

## Fungi.

(By A. Lorrain Smith, F.L.S.)

**Uninucleate Spores of Endophyllum Euphorbiæ.*** — Madame Moreau has taken the opportunity given her in finding a new specimen of this fungus to restate the correctness of her discovery of the uninucleate character of the spores. It is the only case in which an æcidiospore has been discovered that does not possess two nuclei. The author publishes convincing micro-photographs.

**Uredineæ.**—C. G. Hedgecock † has written on the identity of *Peridermium montanum* with *P. acicolum*. He inoculated various plants with the spores, and on *Aster conspicuus* obtained a growth closely resembling *Coleosporium solidaginis*. This he holds as proof that the two Peridermiums are identical, as the stage on the *Aster* is common to both. He discusses the distribution of both *Peridermium* and *Coleosporium*.

J. Weir and E. E. Hubert ‡ give an account of inoculation experiments with *Peridermium montanum*. They obtained the *Coleosporium* stage on species of *Aster* and *Solidago*, a rust already known as *Coleosporium solidaginis*, thus confirming the conclusion came to by Hedgecock.

M. P. Hariot § has published notes on several Uredineæ. A new species, *Puccinia Stewardii*, from Western Australia, is noteworthy as growing on a leguminous plant, *Gastrolobium calycinum*, very few Uredineæ being found parasitic on Leguminosæ. New observations are recorded on *Puccinia verruca*, in which he has discovered uredospores; on *Æcidium Dugettiæ*, a new species on the leaves of *Dugettia* (Anonaceæ); on the æcidia of the Boraginaceæ; on *Uredo moricola*, with its ring of paraphyses round the uredosorus; and on *Ustilago Duriæana*, which was found on *Stellaria media*, a new host.

Marcel Mirande ‖ records a new host for *Uromyces Lilii*. It is an autœcious rust on different species of *Lilium*, and has been found on *Fritillaria meleagris*. Mirande has now observed it on *F. involucrata*. The writer indicates its affinity with *U. Erythronii*, and the points of difference between the species.

**Stinking Smut of Wheat.**¶—This fungus, *Tilletia fœtens*, has been studied in regard to its effect on the wheat plant. The disease appears in the heads of wheat, and M. F. Barrus, the author of the paper, notes a series of observations. Prior to the emergence of the head from the leaf-sheath no difference is observable. After opening out it is seen that

* Bull. Soc. Mycol. France, xxxi. (1915) pp. 68–70 (1 pl.).
† Phytopathology, vi. (1915) pp. 64–7.
‡ Phytopathology, vi. (1915) pp. 68–70.
§ Bull. Soc. Mycol. France, xxxi. (1915) pp. 55–60.
‖ Comptes Rendus, lxxviii. (1915) pp. 530–1. See also Bull. Agric. Intell. Rome, vi. (1915) p. 1707.
¶ Phytopathology, vi. (1916) pp. 21–8.

the pistil of the diseased flower is larger than the healthy pistil, but the stamens are much reduced in size and have a pale yellow colour, the healthy anthers being green. The whole diseased head is slimmer and has an olive-green colour, and the fœtid odour is apparent at an early stage. The conditions are noted at each stage of growth. Finally, at maturity the smut mass in the kernels becomes a mouse-brown colour and is pasty.

**Superposition of Fungi.***—It is not unusual to find a Hymenomycete growing on the pileus of another, generally the same species. P. M. Biers figures and describes two such instances, the one of *Boletus edulis*, the other of *Clitocybe nebularis*. In the latter case the superposed Agaric is as well formed as the individual on which it rests, and to it are attached the basal mycelial strands that prove it to be an independent growth hoisted up by the other, but not in continuity with it.

**Origin and Development of Lamellæ in Coprinus.**†—G. F. Atkinson describes the very early stages of *Coprinus* as being in the form of irregular tubercles scattered on strands of the mycelium; it was only at a later stage that differentiation of tissues could be observed. Atkinson's study is not of these early stages, but of the formation of lamellæ. The primordium of the pileus grows in a radial direction both upward and in a lateral and slightly downward direction, and growth is more rapid in the lateral centrifugal direction; the hyphæ also are richer in protoplasmic content. The zone of radial hyphæ enveloping the pileus he calls the blematogen, a tissue that varies with the different species; thus in *C. micaceus* it becomes free from the pileus in mica-like flakes.

The prelamellar cavity arises by a tearing apart of the plectenchyma in the angle between the pileus and stem "fundaments," due to tension resulting from differences in rapidity of growth. The palisade layer of the young hymenophore begins its formation at or upon the apex of the stem and then proceeds outward, over the under-side of the pileus. The lamellæ originate as downward projecting salients of the palisade tissue, in a series radiating outward toward the margin of the pileus, the younger portion being always towards the margin; they increase in width by apical and also by intercalary growth.

The attachment of the gill margins to the stem takes place after the origin of the gills, beginning where their margins come in contact with the stem, or with the fundamental plectenchyma surrounding the stem. Attachments may begin early or late according to species; there is an interlocking of hyphæ, and also an interwedging of the marginal cells of the gills and trama with the surface cells of the stem.

The cystidia have not been thoroughly studied, but it was observed that in *C. atramentarius* they arose from cells of the trama beneath the subhymenium.

* Bull. Soc. Mycol. France, xxxi. (1915) pp. 14–19 (2 figs. and 1 pl.).
† Bot Gaz., lxi. (1916) pp. 89–130 (6 diagrams and 8 pls.).

**Notes on Agaricaceæ.*** — P. Dumée has become convinced of the probable identity of *Tricholoma melaleucum*, *T. grammopodium*, *T. arcuatum*, *T. brevipes* and *T. humile*. He describes the points on which these five forms agree, not only the field characters but the microscopic details, such as basidia, cystidia and spores. The cystidia are peculiar in having a cap-like ornamentation at their tips. The oldest name is *T. arcuatum*, but the author would prefer *T. melaleucum* as best representing the fungus.

P. Dumée † has received confirmation of his view that *Volvaria speciosa* and *V. gloiocephala* are the same species. A correspondent in Italy watched the development of the former species, and its characters changed during growth to those associated with *V. gloiocephala*.

**Genus Polyporus.‡** — C. G. Lloyd has recently issued a synopsis of the section *Apus* of the genus *Polyporus*. The genus as understood by Lloyd consists of soft fleshy species, annuals except in the tropics. Some of them are stalked, more of them are sessile, and it is these that are now described. They are divided and arranged according to the colour of the tissue and of the spores. There are a very large number of species, each of which is carefully described and in most cases figured.

**Fungi from New Caledonia.§**—N. Patouillard describes a number of new fungi from the above country. *Cyphella crateriformis* on decaying branches has an unusually long stalk and a gelatinous consistency. It is a pure white species. A new genus, *Catilla Pandani*, first placed in the genus *Cyphella*, is also described ; it is a gelatinous form, and the base of the "cup" is occupied by basidia and by cystidia. The remaining new species belong to *Pleurotus*, *Hysterangium*, *Sarcosoma*, and *Nummularia*.

**Insect Fungi.**—G. Arnaud ‖ describes a very large form of *Isaria* from Madagascar, measuring with the insect a height of 13 c.cm. He identified it as nearly related to *Isaria arbuscula*. The author takes occasion to review and compare the allied species of *Isaria*, *Mycomalus*, and *Beauveria* with their conidiophores and conidia.

P. Vincens ¶ describes a new species of *Verticillium*, *V. Barbozæ*, a form of *Isaria* which was found on the chrysalis of a butterfly. It bore a certain resemblance to the fructification of *Isaria arbuscula*. Another species, *Fusarium acremoniopsis* sp. n., was taken from a caterpillar which it affected injuriously. Vincens describes the condition of the host and the fungus.

**Comparative Value of Fungicides.****—J. Vargas Eyre and E. S. Salmon have carried out experiments on spraying fungus pests, more especially American gooseberry-mildew. They found that liver-of-sulphur even in weak solutions injured the young shoots. They recommend a

* Bull. Soc. Mycol. France, xxxi. (1915) pp. 63–7.
† Bull. Soc. Mycol. France, xxxi. (1915) pp. 29–30.
‡ Cincinnati, Ohio, 1915, pp. 291–392 (figs. 631–706).
§ Bull. Soc. Mycol. France, xxxi. (1915) pp. 31–5 (2 figs.).
‖ Bull. Soc. Mycol. France, xxxi. (1915) pp. 20–4 (2 pls.).
¶ Bull. Soc. Mycol. France, xxxi. (1915) pp. 25–8 (1 pl.).
** Board Agric. Journ., xxii. (1916) pp. 1118–25.

solution of ammonium sulphide containing 0·18 p.c. of sulphur; it leaves no deposit on the leaves or fruit, and is therefore not disfiguring, as lime or other washes are. Full instructions are given on the mixing and using of various sprays.

**Study of Rhizoctonia violacea.***—J. Eriksson recalls his experiments on the diseases of carrot, beetroot and rape, caused by *Rhizoctonia*, and the conclusion at which he arrived that in all three instances the fungus was the same species and was a sterile form of *Hypochnus violaceus*, though on these plants it never reached the higher stage. It was only on such plants as *Sonchus arvensis*, *S. oleraceus*, *Myosotis arvensis*, *Urtica dioica*, etc., that the higher fruiting form was produced. In the present paper Eriksson gives results of a series of cultures, more especially with two forms *R. medicaginis* and *R. Asparagi*, the first a virulent disease of lucerne. Specimens of lucerne were examined, the roots of which were covered with a violet mycelium; where the mycelium was thick and abundant no fruiting stage was to be noted, but where it was thin perithecia of *Leptosphæria circinans* were found in groups. Though spore cultures have not yet been completely successful in reproducing the *Rhizoctonia* stage Eriksson has no doubt that the two are connected, and that the fungus on lucerne is therefore different from the one on carrot.

The fungus on *Asparagus* was also tested; in this case sclerotia were freely formed on the outside of the roots, but as no spore-form was found the systematic position of the fungus is undetermined. Attempts to inoculate other plants with either of these *Rhizoctonia* species were unsuccessful.

**Diseases of Plants caused by Fungi.**†—V. P. Stewart has written an account of the leaf-blotch disease of horse-chestnut, which affects a large percentage of the foliage on mature trees in the eastern United States, and is particularly destructive in nursery plantings. Both leaves and petioles are affected, and sometimes the miniature fruits; the disease is marked by the dark red blotches on the leaves. The writer discusses the various fungi that have been described as causing the disease, and determines the ascogenous stage to be *Guignardi Æsculi* nov. comb. Pycnidia are the first fruiting form to appear, scattered on the upper surface of the leaf. Later, spermogonia are formed, with minute oblong spermatia, and along with these latter the perithecia. Full descriptions are given of the developments of these different bodies. In the early stage of ascus formation a uninucleate cell enlarges and gradually assumes the shape of the mature ascus, which at length contains eight ascospores. No intermediate stages were observed. Inoculation experiments were successfully carried out, and artificial cultures were made, but no fruiting-bodies were formed on these. Stewart recommends dusting with sulphur, or spraying with Bordeaux mixture, soon after the foliage is developed.

J. G. Grossenbacher ‡ has had under consideration the various diseases of citrus-trees. There is a group of diseases affecting the bark known as

* Ark. Bot., xiv. (1915) No. 12, 31 pp. (12 pls.).
† Phytopathology, vi. (1916) pp. 5–19 (4 pls. and figs.).
‡ Phytopathology, vi. (1916) pp. 29–50.

gummosis, foot-rot, dieback, canker, and withertip. Canker attacks only the cortex, the others arise from troubles in the phlœm and cambium. The causes of these diseases have not been properly established. Fungi are connected with some of them, but may not be the primary cause. Bacteria may be the cause of canker, but that also is unproved as yet.

H. E. Bartram * has made a study of the brown rot of stone-fruits in Northern Vermont. The fungus causing the rot is *Sclerotinia cinerea*, along with the conidial form *Monilia cinerea*. He made a series of cultures, and investigated the spores of these and other forms. He distinguishes *S. cinerea* not only by the measurements of the conidia, but by the absence of disjunctors, the grey colour of the conidial tufts, and the persistence of the conidia through the winter. They thus cause a danger of infection in the early spring, when conidial tufts may be formed in the first mild moist weather.

J. G. C. Vriens † records the premature death of young *Hevea* branches and of young stems, due to fungi. Attack begins at the tips of the branches, and spreads back to the stems. If very young branches are attacked the damage may not be serious, as the tree may recover in dry weather. Tarring the infected parts is recommended.

Stewart B. Vern ‡ has given an account of some important leaf diseases of nursery stock in the State of New York. The chief of these diseases are :—Apple-scab and pear-scab, caused by species of *Venturia*; apple, cherry, etc., powdery mildew, due to *Podosphæra oxyacanthæ*, or to *P. leucotricha*; rose-mildew, to *Sphærotheca pannosa*; yellow-leaf disease of cherry and plum, due to *Coccomyces hiemalis*, etc., or to the conidial form, *Cylindrosporium*; anthracnose of currants and gooseberries, due to *Pseudopeziza Ribis*; *Septoria* leaf-spot of currants and gooseberries, due to *Septoria Ribis*, of pears, due to *S. piricola*; gooseberry mildew, due to *Sphærotheca mors-uvæ*; leaf-blotch of horse-chestnut, caused by *Læstadia Æsculi*; peach leaf-curl, caused by *Exoascus deformans*; leaf-blight of pear and quince, due to *Fabræa maculata*; and black-spot of roses, to *Actinonema Rosæ*. The majority of the diseases can be controlled or cured by the use of Bordeaux mixture, applied at intervals during the growing season.

B. T. P. Barker and A. H. Lees § give the results obtained in spraying experiments for gooseberry mildew. A soft-soap and paraffin emulsion, with liver-of-sulphur added, was found to be very effective. The bushes were sprayed when the disease was at its height in June, and it was found to be unnecessary to spray again during the summer. It remains to be seen whether the mildew will reappear this year.

**Soilstain of the Sweet Potato.**‖—J. J. Taubenhaus gives the result of three years' investigation of the disease of the sweet potato (*Ipomœa Batatas*) first described by D. B. Halstead in 1890 as "scurf." It is a

* Phytopathology, vi. (1916) pp. 71–8.

† Med. Advis. A.U.R.O.S. Medan, Sumatra, No. 2 (1915) pp. 19–21. See also Bull. Agric. Intell. Rome, vi. (1915) pp. 1706–7.

‡ Cornell Univ. Agric. Exper. Stat., Bull. 358 (1915) pp. 167–226. See also Bull. Agric. Intell. Rome, vi. (1915) pp. 1707–8.

§ Journ. Board Agric., xxii. (1916) pp. 1244–9.

‖ Journ. Agric. Research, v. (1916) pp. 995–1001 (2 pls.).

fungus which only affects the underground parts of the plant, and appears at first as small circular deep-clay-coloured spots on its surface, badly affected roots then becoming deep brown. Wet weather is favourable to its spread. The fungus (*Monilochætes infuscans*) is described thus: "Spores borne in chains which readily break up; conidia hyaline to greenish, guttulate; conidiophores black, several septate: mycelium first hyaline, then darker with age. The submerged mycelium swells irregularly. Conidiophores, 100 to 300 by 3 to 7 $\mu$; conidia, 15 to 20 by 4 to 6 $\mu$." The brown, blotched disease caused by it reduces the value of the mature roots and also the average yield by stunting the development of the younger rootlets. The fungus is difficult to culture from its slow growth and being overrun by associated saprophytes. The conidiophores are distinct from the mycelium; the conidia are borne in chains which readily break up when moistened or disturbed.

## Lichens.

By A. Lorrain Smith, F.L.S.

**Portuguese Lichens.***—Antonio X. P. Coutinho has just published a descriptive list of Portuguese Lichens. In a short preface the author enumerates the different workers on whose collections he has drawn for this list. Chief among these are Welwitsch and, later, Henriques. After each species the name of the collector is given.

Coutinho records in all 298 species. He has followed the classification adopted by A. Zahlbruckner in Engler and Prantl's Pflanzenfamilien.

**Verrucariaceæ of Central Europe. II.**†—Herman Zschake continues his work on this group of lichens. The present contribution deals with *Polyblastia*, which he has divided into various sections; *Coccospora*, with small spores; *Halospora*, spores with a gelatinous wall; *Thelidioides*, spores muriform, colourless—and others. Keys to the species are given, and each species is carefully described.

## Mycetozoa.

By A. Lorrain Smith, F.L.S.

**Mycetozoa of Australia and New Zealand.**‡—W. N. Cheesman and G. Lister have issued a list of Mycetozoa collected by the former during a visit to Australasia with the British Association. There are descriptions of the countries where they were found, both of the soil and the climate. Over one hundred and fifty specimens were brought home, and though no new species occurs amongst them, they are of much value in extending the range of many Mycetozoa, some of which have been considered more rare than they are. G. Lister has determined among them a new variety of *Trichia Botrytis*, as var. *cerifera*, the stalk being studded with waxy deposits.

* Lichenum Lusitanorum Herbarii Catalogus, Lisbon, 1916, 122 pp.
† Hedwigia, lv. (1914) pp. 286–324.
‡ Journ. Bot., liii. (1915) pp. 203–12.

## Schizophyta.

### Schizomycetes.

**Influence of Bacteria on the Production of Perithecia.*** — A. Sartory and H. Roger, working with a species of *Aspergillus*, closely related to *Aspergillus B.* var. *Scheelei* (Bainer Sartory), have observed the appearance of the *Eurotium* form at the end of ten days, when the conidia and the mycelium (impure culture) are transplanted on to damp straw. The number of perithecia arising were very great, and were of a beautiful yellow colour. They were spherical, and varied in measurement from 90–100 $\mu$ in diameter. The thecia, which were spherical, measured 12 $\mu$ in diameter, and contained eight oblong ascospores of from 4·5–5·5 $\mu$ diameter.

It was found that it was impossible to provoke the formation of perithecia by growing the fungus upon the media usually employed in mycology, but when the *Aspergillus* was grown in conjunction with a certain organism belonging to the *B. mesenteucus* group, the *Eurotium* form was constantly obtained. This observation recalls the fact that Molliard showed in 1903 that in the case of another ascomycete (*Ascobolus furfuraceus*) the presence of a bacterium favoured the production of perithecia.

**Studies in Gas Gangrene: The Bacillus of Malignant Œdema.†** M. E. Sacquépée in this memoir gives an extensive description of the *Bacillus Œdematis maligni* (Vibrion Septique), including its morphology (staining reactions, appearance of the capsule, motility, cilia, spores, etc.), its cultural reactions and its biological and pathological characteristics. A great deal of the work covers old ground, but on account of the confusion which has existed regarding the separation of this bacillus from other pathogenic and non-pathogenic gas-producing anaerobes, this paper must be regarded as a welcome addition to the already extensive literature on this important subject.

**Latent Bacterial Infection in Cicatrized Wounds.‡**—P. Lecène and A. Fronin have examined twenty-four cases of healed war wounds, from which the projectile had not been removed, with the view of investigating the question of latent infection. In three cases the projectile, which was extracted and placed immediately in nutritive broth, remained sterile. In sixteen cases the broth tubes gave more or less abundant culture of various micro-organisms, such as staphylococci, streptococci and various unidentified bacilli: the majority of the micro-organisms were facultative anaerobes. In the remaining four cases the projectile and its containing fibrous capsule were removed together. Cultures from the projectile remained sterile, but those taken from the internal layer of the fibrous envelope gave growths of cocci and bacilli.

* C.R. Soc. Biol. Paris, lxxix. (1916) pp. 174–5.
† Ann. Inst. Pasteur, xxx. (1916) pp. 76–108 (1 pl.).
‡ Comptes Rendus, clxii. (1916) pp. 722–4.

**Bacteriology of Ulcerative Stomatitis***—K. Goadby gives an interesting account of the bacteriology of ulcerative stomatitis, which is appearing sporadically among the troops in France as well as in some of the English camps. A smear preparation from the gums, cheeks or throat (stained by Giemsa's method) shows innumerable bacteria of two forms of *Bacillus fusiformis*. Both are Gram-negative. The fusiform bacilli are diplobacilli, 6–7 $\mu$ in length, with pointed extremities; the thickened ends are in opposition with a small clear area between. The organisms are longer and larger than the diphtheria bacillus and are slightly curved: plasmolysis is common. The second or spirillum form closely resembles the spirillum of relapsing fever; it is wavy in outline, irregular in form, and without the characteristic "screw" form seen in *Spirochæta pallida*. Many of the organisms show spiral form; the turns of the thread are but four to six in number, the ends may be pointed, but the organism is usually about the same diameter throughout. These spirochætal forms are variously stated to be:—(1) Spirochætes, and an entirely different species from the *Bacillus fusiformis* (Muhlens and Hartmann, Ellermann, Lenkowicz); (2) a pleormorphic form of the *B. fusiformis* (Vincent, Tunnicliffe). The organism is an obligatory anaerobe, and is also serophile. Generally a small number of pneumococci are found mixed with the other organisms; they are only found with difficulty, and are relatively few in number; they are of importance in producing secondary infection. In chronic cases with such secondary infection, vaccine treatment is especially indicated. The author has also employed vaccines with success in the acute stages, employing the *B. fusiformis*. It is not usually possible to treat with an antogenous antigen of this organism owing to its slow growth, even under strictly anaerobic conditions.

**Bacterial Infection of Eggs.†**—P. B. Hadley and Miss D. W. Caldwell have conducted an investigation in order to ascertain the extent of bacterial infection of fresh eggs, with special reference to the question of (1) embryo-mortality in incubating eggs, and (2) mortality among brooder chicks arising from hens harbouring active or latent natural infections. The eggs were immersed from five to ten minutes in mercuric chloride, 1 in 1000. They were then punctured at one end, the whites poured off and the yolks emptied in specially constructed culture tubes containing broth, similar to those used by Rettger in his experiments. Cultivation was made for four days at room temperature; 2520 fresh eggs were examined, 8·7 p.c. of which showed bacterial infection in the yolk. In 111 cases the whites were also examined, but in every case they proved to be sterile. The percentage of infection obtained for individual hens per year varied from 2·8 to 15·0, the average being 9·0. In no case did any individual hen lay sterile eggs during any full year, and no colleration was observed between percentage of infection and hatchability, nor between percentage of infection and feeundity age of the hens, or the season of the year.

* Lancet, i. (1916) pp. 959-61.

† Agric. Exper. Stat. Rhode Island State College, Bull. No. 164 (1916) 70 pp.

The percentage of infection for unfertile and for fertilized eggs was essentially the same. With regard to the nature of the infecting organisms, from a series of 737 (giving 7·7 p.c. infections), 40 different bacterial types were found; these types included 11 types of cocci, 28 rods and 1 spirillum. There were no streptococci. Only a few of the cocci were chromogenic. *Staphylococcus albus* and *S. citreus* were recognized. Seven of the cocci were Gram-positive and four Gram-negative. Among the bacteria, no representatives of the hæmorrhagic septicæmic group, the intestinal, the proteus, the colon, the enteritidis, the typhoid-dysentery or the diphtheria groups were observed.

**Pathogenicity of Cholera.*** — H. Violle has demonstrated the importance of the proper functioning of the liver and the biliary secretion in cholera infection. The bile alone has only an insignificant action on albuminoids, carbohyrdates and fats. The toxins of the Cholera vibrio have similarly practically no action on fatty substances; a mixture of bile and vibrios, on the other hand have an intense saponifying action on fats, the acids produced having an inhibitory action on the development of the vibrios. The vibrio toxin contains apparently a substance of the nature of a prodiastase which can become activated by organic (bile acids, &c.) or mineral (sulphur, &c.) matters.

The vibrio-bile mixture employed (with adequate controls) was incubated at 37° C. The composition of the mixture was as follows:— Neutral pepton water, 10 c.cm.; litmus, Q.S. to colour the mixture; neutral olive oil, 1 c.cm; fresh aseptic ox-bile, 1 c.cm; Cholera vibrios (Constantinople strain), 24 hrs.; broth culture at 37° C., 1 drop.

**Blastomycotic Meningitis.**† — K. Goto reports a fatal case of Blastomycotic meningitis of seven months' duration. Blastomycetes were present in the cerebro-spinal fluid, which was under high pressure. The albumen content of the fluid varied from 3 to 5 p.c. Microscopically the pia mater was considerably thickened and showed innumerable blastomycotic tubercules with giant cell production. Cultures were made both from the cerebro-spinal fluid and from the meninges. Blastomycetes grew on all the media employed, (agar, Loeffler's medium, ascitic agar, blood agar, glycerin agar, broth, pepton water, gelatin, potato, milk, &c.), but particularly on acid media containing sugar. The organisms grew equally well at room or incubator temperature. The Blastomycetes multiplied by budding; neither mycelium nor spore production were observed. Gas was not produced in sugar-containing media. The fungus stained well with all the ordinary aniline dyes, and gave the iodine reaction and glycogen staining. No toxin production was observed. Mice, rats, rabbits and guinea-pigs were inoculated with cultures of the organisms. Death occurred from one to three weeks later, but meningitis was never observed post-mortem, and giant cells were absent from tissue sections. The dog appeared to be immune.

* Ann. Inst. Pasteur, xxx. (1916) pp. 160–2.

† Mitteilungen aus der Medizinischen Fakultät der Kaiserlishen Universität zu Tokyo, xv. (1915) pp. 75–101 (2 pls. and 1 chart).

**Atypical Dysentery Bacillus.***—F. d'Hérelle has isolated a new strain of dysentery bacillus of a type intermediate to the Shiga and Flexner organism. The bacillus (which was very toxin to rabbits) did not agglutinate with Shiga, Flexner, nor the patient's own serum. The following table shows the points of differentiation at a glance :—

| — | Shiga | Flexner | Hiss | d'Herelle |
|---|---|---|---|---|
| Indol | − | + | + | − |
| Lactose fermentation | − | − | − | − |
| Glucose ,, | + | + | + | + |
| Mannite ,, | − | + | + | + |
| Saccharose ,, | − | + | − | − |
| Shiga serum agglutination | + | − | − | − |
| Flexner ,, ,, | − | + | + | − |
| Hiss ,, ,, | − | + | + | − |
| Pathological action on rabbits | + | − | − | + |

* Ann. Inst. Pasteur, xxx. (1915) pp. 145–7.

# MICROSCOPY.

## A. Instruments, Accessories, etc.*

### (3) Illuminating and other Apparatus.

**An Addition to the Microscope.**†—Under the above title M. A. Ainslie describes an auxiliary, which, placed behind the objective, facilitates correction for cover-glass thickness and for tube-length. If a correction collar be applied to an objective it no doubt obviates to a large extent the change of tube-length without interfering much with the magnifying power, and is useful in other ways, as, for example, in focusing through the various planes of a thick object; but, as it unfortunately appears to be going out of use except in the dry apochromats and in water-immersions, the author leaves it out of consideration. Under the name of a "transformer" the late Van Heurck applied behind the objective a lens of small power, either convex or concave, according to the effect desired, and stated that in this way he was able to use even a 2-mm. apochromat, corrected for the short tube, on the large tube, without any appreciable loss of definition. The explanation is that if a convex or concave lens of low power be introduced immediately behind the objective, it has the effect of altering the degree of convergence of the rays of light projected by the back lens of the objective, and thus of altering the position in which the image is formed. Conversely, if the objective requires, to give good definition, that the image should be formed in a plane either within or beyond the available limits of the tube, it is perfectly possible in the great majority of cases to find a lens of such a power that its introduction above the objective will bring the image within the limits of the tube. It is an advantage to have the additional lens as near as possible to the back lens of the objective; but, if there is any difficulty in fitting it there, it does very well to place it on the nose-piece. The author finds that with objectives of not too high power there is scarcely any limit to the amount of correction which can be thus produced.

One result, which the author believes to be novel, is the possibility by this means of converting an oil-immersion objective into a water-immersion. If the auxiliary lens be suitably chosen, it is found that only the extreme margin of the image is affected, and that with an illuminating cone of about 0·75 or 0·8 N.A. the central definition is quite satisfactory. Here, again, the advantages of the method are more

* This subdivision contains (1) Stands; (2) Eye-pieces and Objectives; (3) Illuminating and other Apparatus; (4) Photomicrography; (5) Microscopical Optics and Manipulation; (6) Miscellaneous.

† Journ. Quekett Micr. Club, xii. (1915) pp. 561-76.

pronounced if the oil-immersion objectives employed are of medium power.

With certain objectives of comparatively low power and small working distance (e.g., a 6-mm. Holos of the earlier construction, N.A. of 0·84) it has been found possible to convert a dry objective into an oil-immersion.

### (4) Photomicrography.

**Practical Principles of Plain Photomicrography.***—Under the above title George West has written a book which will be found to be a very useful and comprehensive manual. He dedicates the volume to E. M. Nelson, and in the foreword states that it is not intended for competition with any of the large and important works dealing with photomicrography already before the public, but rather to supplement such publications on a few points and to give the writer's personal experiences. Its greatest novelty is perhaps the recommendation of the system which was practised by Dr. J. J. Woodward in the United States fifty years ago, and has somehow been overlooked by subsequent operators. Woodward used sunlight as an illuminant, reflecting it by means of an adjustable mirror through a tiny aperture in a shutter into an absolutely dark room. In this room in the path of the sunbeam stood the Microscope, and behind it an adjustable easel for the wet plate, no camera being employed. The disadvantages of depending on sunlight in this country are too obvious, and so West modifies the method by using artificial light, placing the latter along with the Microscope in a light-proof chamber, through a hole in the wall of which the tube of the instrument projects. The plate is placed on an easel in another chamber, to wit the dark-room, where the exposure is made and the plate developed. The photographic apparatus for this purpose is of the simplest form; no camera or dark-slide is used, and the local carpenter, or anyone handy with tools, can readily construct all that is required at a small cost. This plan obviates the difficulty often experienced with the ordinary camera, especially when a number of different objectives are in constant use, of getting the centre of the projected image (which must be central with the optical combination) to coincide with the centre of the screen, as it is merely a matter of arranging the latter to suit the projected image. Another point is that the extension, and, consequently, the magnification, is only restricted by the length of the room. It is, therefore, as easy to expose a 20 by 20 in. plate as a 3 by 3 in., should one require a large picture for demonstration purposes. Another great advantage gained by this simple apparatus is the very important one of being able to see the image in the dark-room on a dull white card placed on the easel in front of the screen. This among other conveniences enables one to detect and rectify any fault, such as unevenness in the illumination, in a way that is impossible with the ordinary camera. The method also offers other advantages such as screening off with a card the effects of sudden vibration and regulating the exposure of parts requiring varying

* Campbell, Sons and Co., Dundee (1916) x and 146 pp. (8 pls. and many figs.).

degrees of exposure, and the author has no hesitation in stating that the method advocated is superior to that of any of the usual cameras. The arrangement he adopts consists of a heavy bench, 8 ft. long by 20 in. wide, having two shelves of the same length and width below for apparatus. The legs stand upon thick pads of felt to minimise vibration; the weight of the bench with its load of apparatus keeping the whole firm and rigid. Upon one end of the bench stands the dark chamber, 3 ft. long, 6 ft. high, and as wide as the bench. This chamber is provided with large light-proof ventilators above and below, as it contains the illuminant as well as the Microscope. The front of this chamber is left open to a height, from the floor of the room, greater than the head of the worker in order to give him access to the contained apparatus. When everything is ready for an exposure a light-proof curtain is let down across the opening. The eye-piece end of the Microscope protrudes at one end of the chamber through a velvet tube, and the projected image is caught on a focusing-screen held on an adjustable easel that can be placed in any position on the unoccupied portion (5 ft.) of the bench. There is an ingenious rod and pulley arrangement for focusing which is worked from the dark-room. As an illuminant the author recommends a good paraffin oil lamp for all ordinary work; it fulfils every requirement as the light given by it is far more actinic to the photographic plate than is generally recognized. The author also strongly recommends the English form of Microscope with a tripod foot, and is a firm believer in its advantages over the continental pattern.

An interesting and useful chapter is that describing the making of a photomicrograph, wherein, by means of a dialogue, "Young Castlebuilder" is trained in the way he should go, by the guidance of "Old Surefoot." Other chapters deal with the vertical camera; special methods of illumination; list of photographic necessities; chemicals and formulæ for solutions; list of useful books. There are some six plates of beautiful photomicrographs, and an elaborate table, giving under fifteen heads all the details of filters, exposures, plates, etc., by which they were produced.

LORD, H. C.—**The Making of a Photographic Objective.**
[A description of a Course in Applied Optics offered at the Emerson McMillin Observatory of the Ohio State University.]
*Ohio Journ. Sci.*, xvi. (1915) pp. 3-16 (7 figs.).

### (5) Microscopical Optics and Manipulation.

**Microscopical Experiment.***—E. M. Nelson describes the following interesting microscopical experiment:—A Microscope is set up with a stage micrometer, with 0·1 mm. on stage; a micrometer eye-piece, having a scale of equal parts in the focus of the eye-lens of a Huyghenian eye-piece, is used; this scale can be moved nearer or farther from the eye-lens of the eye-piece for adjustment to the observer's sight; it, therefore, differs from those of the ordinary small

* English Mechanic, ciii. (1916) p. 271.

tube type, where the eye-lens is moved to focus it to the scale. With the focusing scale the power of the eye-piece, therefore, remains constant. An observer with − 4·D. of presbyopia now compares the magnified image of the stage micrometer with the lines of the scale, and finds that each of the large divisions in the scale is equal to 84 micra.

Another observer, with + 4·0 D. of myopia, now makes the same comparison, but finds that the large division is equivalent to 91·4 micra.

Now, at first, one would think that the myopic observer was using a Microscope of lower power, because he had to get a larger interval in the stage micrometer, or, in other words, a larger object to fill the same space in the eye-piece scale. But a little reflection will show that it is owing to the extra power of the myopic eye making the eye-piece scale larger that a larger object is required to fill it. Abbe asserted that with a simple Microscope the magnification is the same for both kinds of vision, but the above experiment shows that this is not the case. With micrometer eye-pieces of the usual form, i.e. with focusing eye-lenses, the reading with both kinds of eyesight will be the same, because the magnification effect on the scale will be proportional to that on the Microscope as a whole; but when the scale only is focused, the power of the Microscope as a whole remains practically constant, while that of the eye-lens of the eye-piece undergoes considerable change.

Evans, J. W.—**The Determination of Minerals under the Microscope by means of their Optical Characters.**

[This is a full and exhaustive treatise upon the subject.]

*Journ. Quekett Micr. Club*, xii. (1915) pp. 597–630 (3 pls.).

### (6) Miscellaneous.

**Optical Glass: an Historical Note.***—F. J. Cheshire writes to "Nature" as follows:—The subject of optical glass is, at the present time, one of such paramount importance that no apology is needed for introducing it to the attention of your readers. As is well known, the Rev. Vernon Harcourt and Sir George Gabriel Stokes, in the earlier half of last century, laboured together for more than twenty-five years with the object of adding to our stock new varieties of optical glass, but without success. Their labours, however, were afterwards continued by Abbe and Schott, of Jena, who, in the course of some five years, were completely successful. As the result of a critical examination of the work of the English workers, Czapski—then the head of the firm of Carl Zeiss, of Jena—came to the conclusion that Harcourt and Stokes had failed simply because they had not at their disposal the services of a sympathetic and competent glass-maker.

I have quite recently, by the courtesy of a friend, enjoyed the privilege of reading a number of letters, I believe as yet unpublished, written by Abbe, during the period of his work on optical glass, to a well-known English microscopist, now dead. One of these letters, dated October 9, 1881, is very interesting because it sets out very clearly the high-water mark in optical construction attained by optical glasses

* Nature, March 30, 1916, pp. 100–1.

commercially obtainable before the Jena glasses were produced. The relevant part of this letter reads as follows :—

"The Crown and Flint which is applied now by Zeiss—for objectives, prisms, etc.—is within the limits of 1·5017 and 1·8017 refractive index for the D-line. The dispersion of the former is 0·00798, and of the latter 0·03287, measured for the interval between lines C and F. The density of the said Crown is approximately 2·40, and of the said heavy flint 5·1. The Crown above is not the ordinary Crown, which yields $n_D = 1 \cdot 515 - 1 \cdot 520$ and $n_F - n_C = 0 \cdot 00850 - 0 \cdot 00900$; it is a special glass of Feil (of Paris). The Flint named above—also from Feil—is not perfectly white, but the colour (yellowish) is not very perceptible in smaller pieces (lenses or prisms). It may be usefully applied for many purposes, though it leaves a rather great residual of secondary chromatism.

"Feil has made still more refractive Flint, approaching 1·9 in index. But this is strongly coloured and not fit for use in my opinion. The common Flint, which is applied for telescope-objectives, has $N_D$ between 1·60 and 1·63, and $N_F - N_C$ between 0·0165 and 0·0180. The strongest Flint, which is made by Chance Brothers, of Birmingham (i.e. 'double-extra-dense' Flint), has $N_D = 1 \cdot 71 - 1 \cdot 72$ and $N_F - N_C$ between 0·0239 and 0·0241.

"All taken together, we have eighteen different kinds of Crown and Flint in constant use at Dr. Zeiss's workshop."

It is interesting to note that at the time referred to in the above letter Zeiss was entirely dependent upon Chance Brothers, of Birmingham, and Feil, of Paris, for his supplies of optical glass.

The research work commenced by Abbe and Schott in 1881 on a laboratory scale was so far successful that Abbe, writing in a second letter on February 21, 1883, says :—

"Regarding the glass experiments, of which I have told you a year ago, I may say, that they have had a very satisfactory progress, as well in regard to the purely scientific aims, for which the research had been undertaken, as in regard to the practical results which are obtained. We are now satisfied that the utilization of these results for the fabrication of optical glass will be the basis of a good progress of practical optics in several respects. The question is now only how to introduce the results of the experimental research into the fabrication; for all that can be done in the laboratory is settled now, or nearly settled. For that other aim I have had already, during several months, long and troublesome negotiations in order to obtain for my fellow-labourer that assistance which could enable him to undertake the practical application of the long research. Even now, however, it is not yet settled that this will be possible—at least in the manner as it has been planned until now, and within a moderate time. But at all events, the quick utilization of the research in favour of microscopic optics will not be questionable: we have obtained already, or will obtain within the next time, by mere laboratory operations, sufficient quantities of the new glasses, which are of interest for the Microscope, for enabling Zeiss to begin with the practical application in this year (which notice, however, I request you to consider as a private one at present, because it would

not be agreeable to have this matter spoken of long before it is a matter of fact)."

This letter is very interesting, because it shows that at the time in question, so far as the comparatively small quantities of special glasses required for the production of Microscope objectives was concerned, the laboratory output was sufficient to enable the work to be done. This fact at once points to the possibility of meeting the demand at the present time for very special glasses required in small quantities only, as, for example, the production of Microscope objectives by laboratory rather than by factory methods.

The production of glass on a manufacturing scale was commenced at Jena in 1884, and was brought to a successful conclusion in 1886, when the first catalogue of the Jena glasses was issued.

The third letter written by Abbe is dated March 4, 1886, and was accompanied by one of the first—if not the first—homogeneous immersion apochromatic Microscope objectives made. The letter reads as follows :—

"This is a homog. immersion of 1·40 apert. and 3·0 mm. focal-length, constructed by means of new kinds of optical glass which have been produced on the base of a systematical research into the optical qualities of the various elements admitting of vitrification. This research has been conducted through about three years in the way of laboratory work, chemical and optical, by myself and a fellow-labourer of the chemical and technical line (Dr. Schott) with the continuous assistance of two younger scholars, chemists and physicists ; and has afterwards—nearly two years ago—induced the foundation—at Jena—of a technical establishment for the regular fabrication of all kinds of optical glass for general use. This glass-manufactory (which has been set up in 1884 by Dr. Schott, Messrs. Zeiss, and myself, with the aid of a subsidy of the Prussian Government) has taken up, and continued, the former experiments on the scale of fabricatory work, in order to make the results available for the various branches of practical optics. This is going on still—some tasks being settled (the production of the silicious glasses, which is in a regular fabrication since last summertime), other tasks being brought near to the aim. In the meanwhile, I have gone to work with theoretical research and computation ; in order to find the proper formulas for the utilization of the new kinds of glass in the construction of telescope objectives and Microscope objectives.

"Regarding the latter aim, a series of objectives adjusted for the short continental tube is nearly finished ; another series for your English Microscopes—which requires different formulas—has been begun ; and you and Mr. —— have at hand the first specimens of that series.

"The optical features of the new constructions, which are represented by this 1/8th of 1·4 ap., may be defined in that way ; the various corrections are of a higher order than could be obtained formerly (or, more strictly spoken, the residuals of the various corrections, i.e. the defects of collection of the rays, are of a higher order according to mathematical terminology). 1. With the old kinds of crown and flint glass two different colours only could be collected to one focus, a

secondary spectre remaining uncorrected. With the new glass those different colours unite at one point, a tertiary deviation being left only. 2. Formerly the spherical correction was confined to the rays of one colour; this correction being made for the middle part of the spectrum, the systems remained under-corrected, spherically, for the red rays, and over-corrected for the blue rays. Now the correction of sph. aberr. is obtained for two different rays of the spectrum at the same time, and the objective shows the same degree of chromatical correction for the central as for the marginal part of the aperture. (Of course, this higher degree of correction is not given by the glass from itself—it requires a very careful utilization of the optical properties of the various kinds of glass at disposal, in order to fulfil all those conditions, and this was not even possible except by means of a greater complication of the constructions; I was obliged to introduce five separate lenses (for the aperture 1·4) instead of the four applied hitherto).

"The objective at hand is constructed on the single-front-type. It contains ten single lenses in five separate parts. Two only of these ten lenses contain silicious acid; the glasses of the other eight are phosphates and borates—the Crown and Flint glass which has been used by the opticians hitherto does not contain, as essential constituents, more than six chemical elements, O, Si, K, Na, Ca, Pb; the lenses of the 1/8th contain, as essential components of the glass, not less than fourteen elements."

"I did not introduce a greater aperture than 1·40 in order to preserve a convenient working distance—which, in fact, is $=0·25$ mm. $=1/100$ in. The two oculars sent with the objective are constructed with the aim to compensate certain aberrations outside the axis, which cannot be got rid of in the objectives (of wide aperture). The whole series of objectives, high and low powers, shall be so arranged, that this compensation is always obtained by the same series of oculars."

This last letter, I think, will be accepted as setting out *inter alia* in a remarkably lucid way the optical advantages obtained by the introduction and employment of the Jena glass in optical constructions.

**Achromatoscope.*** — S. R. Williams describes the arrangements adapted to testing substances for achromatic combinations which have been called achromatoscopes, because without the necessity of measuring the refractive indices we can tell by inspection where there is achromacy or not. The various systems consist essentially of devices for viewing two spectra in juxtaposition in which one is a channelled spectrum from one film and the other is from another thin film. Any comparison spectrometer may be used. The author's method has especial significance when applied to thin films of various kinds of glass in order to select the best achromatic lenses. Preliminary work in testing the achromacy of various liquids would indicate that for some purposes liquid lenses might be used to a great advantage. The liquids would have to be held in glass containers which were ground to the proper curvature, but whose walls were parallel surfaces. The author describes his apparatus and the theory on which it is based.

* Amer. Journ. Sci., xli. (1916) pp. 101–11 (8 figs.).

**Micro-counting Slips.*** — N. D. F. Pearce has lately had occasion to make for the Lister Institute a number of micro-counting slips. Those formerly in use are now unprocurable, being of German origin. His slides (fig. 21) are simply an ordinary 3 by 1 slip on which are cemented three pieces of thin glass of such a thickness that when a drop of the preparation to be examined is placed on the central one, and a cover-glass laid over all three, the film of liquid shall be 0·1 mm. thick. Using an eye-piece micrometer, with squares of known value, the bacteria, blood corpuscles, &c., in so many fields are counted, and thus the number present in any given volume of fluid can be calculated.

The method of preparation requires care. The slides must be chosen truly shaped and of uniform thickness. If this cannot be

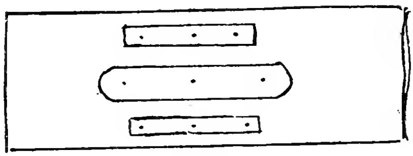


Fig. 21.

attained, a record must be kept of the calliper readings so as to know the variations. The strips of glass must be a little too thick, and after cementing on must be carefully and accurately ground down. It is fairly, but not very, easy to get the final thickness 0·1 mm. There are many details as to the precautions necessary to secure success, and for these the original paper should be consulted.

**Masonry Bases for the Installation of Microscopes and their Accessories, including the Camera Lucida and the Microscope Camera.**† — N. A. Cobb advocates the advantages of installing Microscopes, especially those intended for critical work, on heavy pillars having foundations in the ground and passing upward through the floors without contact.

A similar method has long been in use in the best laboratories for mounting instruments of precision. He describes in detail one such installation which was carried out in cement and steel. Three girders, two approximately eight inches in each transverse dimension, and between them a third smaller one, were imbedded vertically to the depth of several feet in a block of cement weighing many tons located under the building. The middle short girder, extending 18 in. above the floor, carries the Microscope and certain accessories connected with illumination. The two tall, paired girders extend to within 18 in. of the ceiling, projecting upward into the room about 11 ft. The wooden floor was laid tightly about the girders after they had been set in the cement, and everything was then given a few months in which to settle

* English Mechanic, cii. (1916) p. 573 (1 fig.).
† English Mechanic, ciii. (1916) pp. 322–7 (5 figs.). Reprinted from Trans. Amer. Micr. Soc.

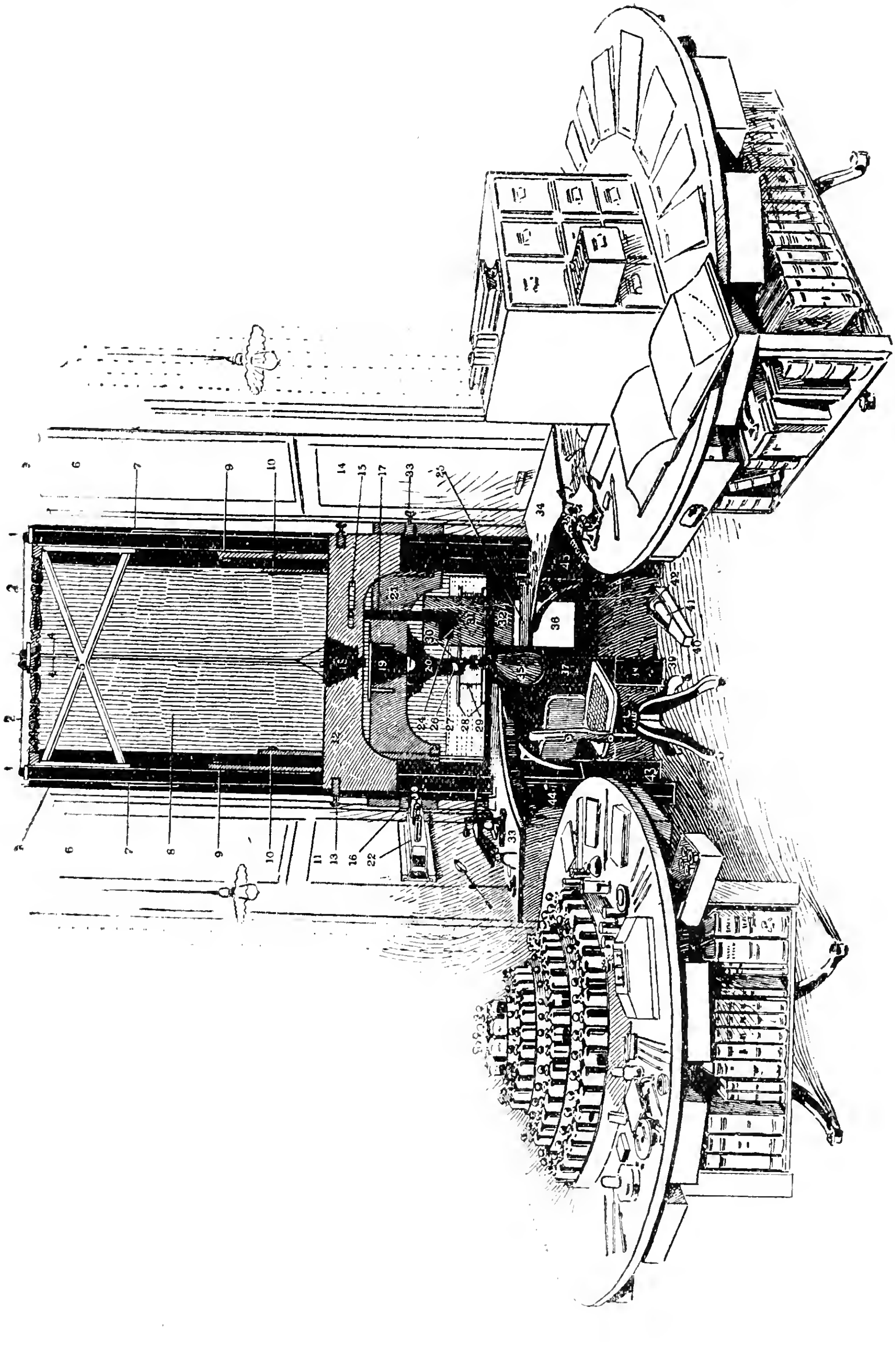


Fig. 22.

into permanent position, after which an ordinary key-hole saw was run through the floor entirely around the contour of each girder, so that each cleared the flooring and floor-covering by the thickness of a saw-blade. The author describes fully the ingenious arrangements whereby the girders, which clear the wall of the room by an inch or two, carry the accessory apparatus. This apparatus is attached to them in some instances by means of sliding one-sixteenth-inch sheet-metal sleeves that may be clamped at any desired height; in other instances by other means. All parts are dead black.

A second mode of installation involves bolting small vertical I-shaped or Z-shaped girders to the masonry of the building.

A third mode depends upon the substitution of steel tubes, $3\frac{1}{2}$ ins. to 6 ins. internal diameter, for the girders. This method possesses certain special advantages, inasmuch as the tubes are externally suitable for the attachment of collars and sliding rings, and internally for the reception of counterpoising weights.

The author gives full descriptions and illustrations of all arrangements.

Fig. 22 shows the author's up-to-date microscopical laboratory, in which the constructional work has been carried out on the first of the above methods.

## B. Technique.*

### (1) Collecting Objects, including Culture Processes.

**Plating Dishes for the Cultivation of Bacteria.**† — S. Delépine makes the following communication:— Owing to the difficulty of obtaining at the present time suitable dishes for making plate cultures I have adopted several devices.

1. The object of the first was to utilize the stock of Petri dishes which I had in the laboratory, which was insufficient when it became necessary to have some eight hundred dishes available daily in connexion with our military work alone.

I had a number of shallow flat metal lids made to fit the tops and bottoms of the existing dishes, so that each Petri dish could be utilized to make two plates, thus doubling the stock available (fig. 23). I found that these metal lids when well tinned answered their purpose. They, however, require frequent polishing in order to keep the surface smooth and free from rust.

2. I have also made plating dishes by inserting round pieces of plate glass in a thin rim of well-tinned metal or waterproofed cardboard, etc. (fig. 24). These plating dishes are very much cheaper than the old-fashioned Petri dishes, and appear to me to be better, because the glass

* This subdivision contains (1) Collecting Objects, including Culture Processes; (2) Preparing Objects; (3) Cutting, including Imbedding and Microtomes; (4) Staining and Injecting; (5) Mounting, including slides, preservative fluids, etc.; (6) Miscellaneous.

† Brit. Med. Journ., April 22, 1916.

bottom is perfectly flat and of equal thickness, and permits of the media being more evenly spread. They stand sterilization perfectly well, and the bottom is clearly visible up to the edge. I have by numerous experiments ascertained that tin does not appreciably affect the growth of bacteria; aluminium is less suitable, but duralumin could be used instead of tin, if sufficiently thin rims could be made with this alloy.*

3. A more expensive form of metal rim has also been made for me, which consists of two concentric rings of well-tinned metal (block tin or

Fig. 23. Fig. 24.


1. One half of a Petri dish with a metal lid to replace the other half. The unevenness of the bottom of the Petri dish is exaggerated.
2. A plating dish made by forcing a glass plate into a flexible metal rim.

duralumin would be better): the inner is screwed into the outer, which is provided with a flange, against which the glass bottom plate is fixed when the inner rim is screwed home (fig. 25). The advantage of this form, which is more expensive, is that the glass plate can be replaced easily when broken.

4. A much older design (which I used as far back as 1887, in order to obtain even layers of cultivating media, and plates more suitable for photographic purposes than those made in Petri dishes) is even simpler, but somewhat less convenient than the previous forms. It consists of

Fig. 25. Fig. 26.


3. A "plating dish" made by fixing a glass plate by screwing two metal rings together.
4. A "plating dish" made by fixing a rim of metal to a glass plate by means of coagulated albumen or collodion.

a square or round tin frame; one surface is perfectly flat, and is fixed to a bottom glass plate by means of coagulated blood serum, collodion, or oxidized linseed oil (fig. 26).

To make a plating dish with such a frame, a perfectly clean glass plate of suitable size and shape is placed over a metal plate heated to the temperature of boiling water. The surface of the frame which is to be fixed to the glass is painted evenly with fresh blood serum or white

* The Action of some Metals upon Certain Water and other Bacteria. Journ. Roy. San. Inst., xxxv. No. 6 (1914).

of egg. The frame is then pressed with the painted surface against the hot glass, and allowed to remain under slight and even pressure for a quarter of an hour or longer on the hot plate. At the end of that time the albumin is quite coagulated and dry, and the frame is so firmly adherent that sterilization by steam can be carried out several times without causing any separation.

**New Apparatus for Bacterial Fermentation Tests: Fermentation Bulbs.***—S. Delépine makes the following communication:—Soon after the beginning of the war the price of various sugars and other products used in fermentation tests was so high, and it was so difficult to get sufficient stocks of them, that it became at times impossible to carry out all the tests required for the identification of bacilli isolated from the very large number of cases which had to be examined bacteriologically in Manchester for the 2nd Western Military Hospital.

To meet this difficulty I adapted a method which I devised about sixteen years ago, and have used from time to time for the purpose of studying, collecting, and measuring the gases generated by definite quantities of fermentable fluids. In order, however, to meet the difficulty mentioned above, I reduced the size of my apparatus to a minimum.

This small fermentation apparatus consists of a tube 4–5 c.cm. in length, with a 2 or 3 mm. internal bore. The closed end of the tube is in the form of a small bulb, measuring 7 or 8 mm. in diameter, and of a capacity not exceeding 0·5 cm. The tube looks very much like the bulb end of a thermometer. These little tubes are inserted mouth downwards into other glass tubes of suitable diameter, which are themselves kept vertical by being inserted into the holes of a wooden rack. The bulb of the fermentation tube closes the upper end of the supporting tube. The two tubes can be sterilized together by steam. After sterilization they must be thoroughly dried in the hot-air oven.

To introduce the fermentable medium into the bulbs, special burettes are used provided with a capillary delivery tube which can be pushed down to the bottom of the fermentation bulbs.

Each burette contains enough fluid to fill about 100 fermentation bulbs. After the burettes have been filled with the fermentable fluid, they are sterilized with their contents, the delivery pipe being protected by a glass sheath. When the fermentable tubes have to be filled they are held vertical, mouth upwards; the delivery tube (after flaming it, if it has been exposed to contamination) is inserted to the bottom of the fermentation bulb, and enough fluid is allowed to flow to fill the bulb, and about 8–10 mm. of the stem. The tube is then inverted and placed again mouth downwards in the supporting tube.

A set of tubes with the various fermentable media can easily be arranged in the rack provided for the purpose. A great number of such sets can quickly be prepared.

It is best to place these racks with the fermentation tubes ready for use in the incubator at 37° C. for twelve hours previous to using them. At the end of that time any gas which may be in solution in the fluid

* Brit. Med. Journ., April 29, 1916.

will have separated in the shape of minute bubbles. This gas is got rid of by shaking the bulb like a clinical thermometer and heating the tube gently near the free surface of the fluid.

When the bulbs have been prepared in this way they can be kept for several weeks ready for use. The fluid remains in position, provided the tubes have been filled exactly as stated above. When the bulbs have to be stored for several days before being used, it is best to keep them with the bulb down, the mouth remaining protected by the supporting tube.

The fermentation tubes are easily inoculated by means of a platinum needle or loop brought in contact with the surface of the fluid, and gently shaken in it. The needle may be removed carefully, so as not

1. Burette containing one of the sterilized fermentable media. The medium has been sterilized in the burette. The capillary delivery pipe is protected by a glass sheath until it is going to be used.

2. Fermentation bulb (sterilized) ready to be filled with the fermentable medium through the capillary delivery pipe of the burette. (A long hypodermic needle is suitable for this purpose.)

3. Fermentation bulb in a sterilized supporting glass tube. Sets of these tubes containing series of fermentable media are kept ready for use in racks.

4. Fermentaton tube taken out of its supporting tube and inoculated by means of a platinum or palladium* needle. A Pasteur's pipette of suitable shape can also be used in the same way, but care has to be exercised to avoid an excess of fluid.

5. Result of a test with production of gas and change of reaction of the medium.

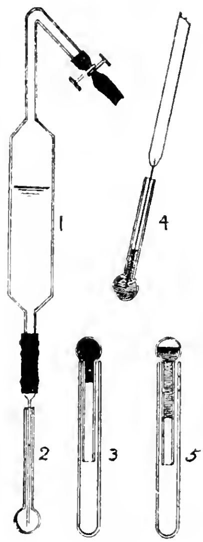


FIG. 27.

* Owing to the difficulty of obtaining platinum at the present time, I have adopted palladium as a substitute for platinum, after ascertaining that this metal has no appreciable lethal action on bacteria.

to cause any of the fluid to be carried to the mouth of the tube. This does not happen readily if the tubes are kept mouth upwards during inoculation.

All the reactions which can be observed in other kinds of apparatus are observed clearly in my bulbs, which present important advantages over the Durham's tubes at present in general use:—

1. The total amount of gas generated under aerobic and partly anaerobic conditions out of a certain amount of medium is collected.

2. The first stages of the reaction are easy to observe, can be detected very early, and can be easily timed.

3. The colour of the litmus, when this indicator is used, is not affected by sterilization, as it is in the Durham's tubes.

4. The amount of fluid used is very small.

5. The fermentation bulb is not expensive.

**Plurality of Species of "Thrush-fungus."***—A. Castellani, as the result of researches in Ceylon and at the Lister Institute, London, has come to the conclusion that the term "thrush-fungus" (*Monila*, *Saccharomyces*, *Oidium*, *albicans*) does not indicate a single species of hyphomycete, but both in temperate and tropical zones has been used to cover a large number of different species. In London, from eleven cases of thrush, seven different species of fungi belonging to the genus *Monila* were found. None belonged to the genus *Endomyces*, no endospores and asci having been seen. They all grew abundantly on the various sugar-agars, especially if slightly acid; less abundantly on ordinary agar. On solid media the fungi could hardly be distinguished one from the other. The growth was abundant on all, of a white creamy colour. The fungi grew under two forms: a globular form, morphologically similar to a typical yeast, and a filamentous form, showing mycelial threads simple or ramified—asci and internal spores were always absent. The cultural characters of seven of these species are shown in the following table:—

| — | Litmus Milk | Glucose | Laevulose | Maltose | Galactose | Saccharose | Lactose | Mannite | Dulcite |
|---|---|---|---|---|---|---|---|---|---|
| *Monila*, No. I | 0 | A.G. | A.G. *v.s.* | A.G. *s.* | A | 0 | 0 | 0 | 0 |
| *Monila*, No. II | C. | A.G. | A.G. | A.G. *s.* | A. | A. | 0 | 0 | 0 |
| *Monila*, No. III | C. | A.G. | A.G. | A.G. *s.* | A.G. | A. | A. | A. | 0 |
| *Monila*, No. IV | C. | A.G. | A.G. | Alk. | A. | A.G. | A. | 0 | 0 |
| *Monila*, No. V | C. | A.G. | A.G. | A. | A. | A. | A. | 0 | 0 |
| *Monila*, No. VI | C. | A.G. | A.G. | A.G. | A. | 0 | 0 | 0 | 0 |
| *Monila*, No. VII | C. | A.G. *v.s.* | A. | A.G. *v.s.* | A. | A. | A. | 0 | 0 |

A. = acid; Alk. = alkaline; C. = clot; G. = gas; 0 = negative; *s.* = slight; *v.s.* = very slight.

For *Monila* No. I, the name *Monila Metchinkoffi* is proposed. The fungi found in the London cases were different species from those found in the Ceylon and South Indian cases.

**Standardized Employment of Vaccines.†**—Lyon Smith and Cassés Brown have devised the following technique for estimating the propor-

* Ann. Inst. Pasteur, xxx. (1916) pp. 149–54.
† Lancet (1915) ii. p. 279.

tions of different organisms to be used in a mixed vaccine. It is based on the fact that when blood-corpuscles, washed free from fibrin and serum, are treated with emulsions of various bacteria with which the blood has previously been in living contact, hæmolysis occur with them, and with no others. The greater the hæmolytic action, the greater the proportion of that organism that must be used in the subsequent treatment. Minute test-tubes (30 by 3 mm.) are arranged on plasticine and numbered. In each tube are placed 0·1 cm. of 5 p.c. emulsion of the patient's blood-corpuscles. To successive tubes is added 0·1 cm. of bacterial emulsion from the stock series. Incubate for ten minutes. The tubes in which hæmolysis has occurred are noted. The incubation is repeated for periods of ten minutes up to one hour. The hæmolytic power of the various strains is thus relatively determined. A control with normal saline is needed, as a guide to variations of hæmolysis due to the salt-content of the blood. Graded quantities of vaccine will be prescribed according to results.

**Cultivation of Green Algæ.***—J. B. Petersen obtained pure cultures of green algæ on gelatin to which the following inorganic salts were added :—Nitrate of calcium 1·5 grm., chloride of potassium 0·5 grm., sulphate of magnesium 0·5 grm., phosphate of potassium ($KH_2PO_4$) 5 grm., chloride of iron, a trace. The water in which the foregoing ingredients was dissolved was 1000 grm., and the gelatin 100 grm. The algæ which prospered on this medium were *Stichococcus minor*, *Chlorella ellipsoidea*, and *Coccomyxa Nägeliana*. Later, the author used an agar base, as follows :—Agar 15 grm., $KNO_3$ 1 grm., $MgSO_4$ 0·25 grm., $K_2HPO_4$ 0·25 grm., distilled water 1000 grm. This medium was placed in Petri's capsule, and the algæ sprayed over the surface. The author then refers to Hedland's method of cultivating algæ on slides.

**Blood-cultures on Dried Bile.**†—A. Le Boeuf and P. Braun find that dried bile is just as good for cultivation purposes, and much more convenient. The fresh bile is sterilized at 125° C. for thirty minutes, then filtered through Chardin paper or cotton-wool. The filtrate in a flat vessel is inspissated by means of a water-bath. After cooling, the mass hardens, becomes friable, and is easily pounded up in a mortar. 1 grm. of the dried and powdered bile corresponds to about 10 c.cm. of liquid bile. 1 grm. of the dried bile is placed in a test-tube ; it is then again autoclaved, and while still warm slopes are made. To make a blood-culture, 5 c.cm. of blood are poured into the tube containing bile. The blood dissolves the bile, and the tubes are placed in an incubator and the growth examined later. Like solmedia shown before the Society, it is very convenient to use, easy of transport, and of necessity is easily soluble.

* Mém. Acad. Roy. Sci. et Let. Denmark, Sect. Sciences, xii. (1915) pp. 272–379 (4 pls.).

† C.R. Soc. Biol. Paris, lxxix. (1916) pp. 212–6.

### (4 Staining and Injecting.

**Demonstrating Frog Lung-flukes.***—W. W. Cort gives the following technique. The worms for sectioning were usually killed after shaking in corrosive sublimate plus 1 to 3 p.c. acetic acid. The specimens which were destined for toto mounts were usually transferred into distilled water before killing, in order that part of the eggs might be evacuated. After this treatment they were killed without shaking. All specimens were left in cold killing fluid from six to eighteen hours, but when hot fluid was used less time was required. For toto staining, Mayer's paracarmin, Mayer's hæmalum, and Delafield's hæmatoxylin were found most useful. The worms were much overstained in dilute solutions, and then very rapidly and completely detrained in 2 to 4 p.c. HCl in 70 to 80 p.c. alcohol. This method of differentiation has been found useful for most toto mounts of Trematodes, since in this way almost all the parenchymatous tissue is cleared of stain, so that the internal organs stand out clearly. For staining sections, hæmatoxylin with eosin as a counter is a good combination. Much time can be saved by staining the worms in toto in Ehrlich's hæmatoxylin, differentiating on the slide after sectioning, and then counterstaining in the higher grades of alcohol. By this method it is not necessary to run the sections on the slide through a lower grade of alcohol than 85 p.c. The only difficulty in the technique of the frog lung-flukes is due to the presence of great masses of eggs. In some of the largest specimens sectioning became almost impossible on account of these great masses of eggs.

### (6) Miscellaneous.

**Sterilized Pus as a Vaccine.**†—Nesfield finds the injection of sterilized pus useful in the treatment of deep-seated abscesses, septic wounds, compound fractures, mastoid disease, osteomyelitis, septic operations, etc. The pus is taken from the patient's wound and prepared as follows: wipe the interior of a 1 oz. wide-mouthed bottle with tinct. iodi., and rinse out with 1 in 50 p.c. solution of phenol. Treat the glass stopper in the same manner. Collect the pus in the bottle and add an equal volume of 1 in 50 carbolic. Put in a piece of camphor and allow the mixture to stand for twenty-four hours, or longer, in a cool place. A dose of 2 min. is given on the first day, raising the dose by 1 mm. each day until 17 min. are given on the sixteenth day. Thereafter, if required, 10 min. may be given on alternate days. Induration may occur at the site of inoculation and a slight rise of temperature may be noticed. The prophylatic dose is about 5 min. (The process may be simplified in the laboratory by using vessels sterilized in the ordinary way.)

**Rapid Method of Doing Widal's Reaction.**‡—A. C. Coles recommends the following rapid and simple technique for the determining, or

* Trans. Amer. Micr. Soc., xxxiv. (1915) pp. 203–40 (3 pls.).
† Ind. Med. Gaz., 1914, pp. 471–4.
‡ Brit. Med. Journ., i. (1916) p. 684.

at least strongly suspecting, the presence or absence of typhoid in a non-inoculated person.

With a coloured grease glass pencil, or a piece of wax, draw a line across the middle of two slides at right angles to their long axes. Spread a film of the blood to be examined on one half of each slide, and, when dry, spread a film of one's own blood, or that of a person who has not had typhoid or who has not been protectively inoculated against it, as a control, on the other half of each slide. The film may be as thin as that ordinarily used for stained films, or a little thicker. Dry. By means of a platinum loop or pipette place a small drop of an emulsion of killed typhoid bacilli on the centre of each half of both slides, and with the platinum loop, rub the drop well over the film of blood, taking care not to pass from one half of the film to the other without sterilizing the needle. On one slide carefully place a cover-glass on each half, taking care that the two cover-glasses are well separated in the middle by the mark of the grease pencil. Place the other slide in a piece of wet blotting-paper, and cover with a Petri dish to prevent evaporation, for a period of fifteen to twenty minutes. At the end of that time dry carefully over the flame, and then stain.

Examine both halves of the first slide under the Microscope. After fifteen minutes clumps of agglutinated bacilli will be seen, if the blood be from a typhoid case or from an inoculated person, while on the control half of the slide the bacilli will show no sign of clumping. The film, stained with Leishmann or Giemsa, will show on one half patches of agglutinated bacilli, while on the control half the bacilli will be more or less evenly distributed. Paratyphoid A and B fever can be diagnosed by a similar proceeding, employing cultures of these organisms, instead of the typhoid bacillus.

## Metallography, etc.

**Copper-zinc-tin Alloys.*** — S. L. Hoyt and P. H. M. P. Brinton discuss the nature of the grey constituent formed by adding tin to the brasses. It is probably not a ternary phase, but a phase belonging to one of the binary systems.

**Ball-test on Cast Metals and Alloys.†**—The properties of a metallic crystal are different in different directions relative to its crystalline orientation. A. Portevin has studied the variation of mechanical properties with direction by determining the form of Brinell ball impressions made on single crystals, or on a number of similarly oriented crystals, seen in polished and etched sections. The specimens had been slowly cooled from the liquid state, in order to develop a coarse crystallization. The impressions were generally square, with rounded corners, or oval; their measurements relative to the dendritic directions are given for two specimens of copper containing respectively small amounts of vanadium and aluminium, and for antimony, iron, zinc, brass, and a copper-tin alloy.

**Metallic Crystal Twinning by direct Mechanical Strain.‡**—C. A. Edwards describes experiments made in order to determine whether the acicular markings formed on the surfaces of tin and zinc by mechanical strain are twin crystals or merely appearances which do not extend below the surface. The specimens were cast on polished steel surfaces, previously heated to about 150° C. A gentle pressure was applied to the upper surface of the liquid by means of another piece of polished and heated steel. The specimens were etched, examined for twin crystals, and then strained. Twin markings were formed more readily when the surface was strained in compression than when it was strained in tension. A layer of appreciable depth was removed from the surface. This was done by immersing the specimen in strong acid, since any mechanical method—even the lightest rubbing on the finest emery-paper—caused very serious disturbance of the crystal structure. After the attack by acid the surface was polished on chamois leather, and etched as before. It was found that the twin markings formed on the original strained surface persisted after the removal of the surface layer, indicating that twinning had actually occurred as an effect of mechanical strain alone.

**Structure of High-speed Tool Steels.§**—In the course of an investigation into the effect of chromium and tungsten upon the hardening and tempering of high-speed tool steel, C. A. Edwards and H. Kikkawa

* Journ. Inst. Metals, xiv. (1915, 2) pp. 178–88 (6 figs.).
† Rev. Métallurgie, xii. (1915) pp. 95–100 (2 figs.).
‡ Journ. Inst. Metals, xiv. (1915, 2) pp. 116–44 (21 figs.).
§ Journ. Iron and Steel Inst., xcii. (1915, 2) pp. 6–46 (30 figs.).

have microscopically examined the hardened and tempered specimens. The structures observed in a steel containing 0·64 p.c. carbon, 6·24 p.c. chromium, and 17·69 p.c. tungsten, are described as typical. After cooling in an air-blast from 1350° C. this steel consisted of polygonal austenitic crystals. After tempering at 494° and 589° C. the structure was quite martensitic. After being heated to 638° C. the specimen was more readily etched, and showed signs of the decomposition of the martensitic structure, but the martensitic markings were not completely removed until a temperature between 700° and 750° C. was reached. The steel was fully annealed at 784° C., and began to harden again on heating to 884° C. and cooling. The structures of steels which had been overheated or partly melted showed unmistakable signs of this treatment.

**Nitrogen in Iron and Steel.***—N. Tschischewski has included with other experimental work on iron and nitrogen an examination of the structure of Swedish iron which had been treated in a current of ammonia gas. Transverse sections of the specimens, polished and etched, showed at the edge the brittle skin of iron-nitride. Under this was a dark layer, etching very easily, apparently consisting of iron and crystals of iron-nitride. The dark crystals became less numerous towards the centre of the specimen. The changes caused by heating to various temperatures and cooling rapidly or slowly are considered to indicate that the iron-nitride forms a solid solution with iron on heating, and falls out of solution on cooling; a eutectic structure was not produced.

**Carburization of Iron in Blast-furnace Gases.**†—T. H. Byrom has found that iron may be completely converted into carbide of iron by exposure to blast-furnace gases at temperatures in the neighbourhood of 500° C. for a sufficiently long period. After a fortnight's exposure, strips of electro-deposited iron were found to be coated with layers of carbide, between which was a layer consisting of crystals of iron enclosed in inter-crystalline envelopes of carbide. The formation of the carbide appears to be due entirely to the action of carbon monoxide.

**Oxygen in Iron.**‡—W. Austin gives a number of photomicrographs of iron containing 0·24 p.c. oxygen. The material was prepared by melting iron with iron oxide in an electric-arc furnace. The highest oxygen-content obtained was 0·29 p.c. The oxide occurred as an independent constituent, in the form of globules. A surface examined after polishing, and then after heating in hydrogen at 700° C., showed that the oxide was reduced by this treatment; the etching effect of the hydrogen was also observed.

**Phosphorus in Iron and Steel.**§—W. H. Hatfield has examined microscopically a series of seven white irons in which the phosphorus

* Journ. Iron and Steel Inst., xcii. (1915, 2) pp. 47–105 (21 figs.).
† Journ. Iron and Steel Inst., xcii. (1915, 2) pp. 106–21 (7 figs.).
‡ Journ. Iron and Steel Inst., xcii. (1915, 2) pp. 157–63 (10 figs.).
§ Journ. Iron and Steel Inst., xcii. (1915, 2) pp. 122–40 (19 figs.).

varied from 0·046 to 0·83 p.c., the carbon-content remaining constant at 2·9 p.c. The alloys were examined as cast, and after annealing at 900° C. for two and a half days and cooling slowly. Stead's cupric reagent deposited copper readily on the low-phosphorus specimens, and less readily as the phosphorus-content was higher, but did not give completely satisfactory indications of the distribution of the phosphorus within each specimen. A ring surrounding each nodule of carbon in the annealed specimens remained free from copper, but this could not be due to local high phosphorus. The author suggests that during the cooling of steel through the critical ranges the phosphorus may become concentrated, together with the carbon, in the pearlite areas.

**Metallography.**— H. Le Chatelier gives an account of the origin and development of the science of microscopic metallography. Successive improvements in the technique of polishing, etching, and photomicrography are described. The application of metallography to the study o alloys is illustrated by numerous photomicrographs.

* Rev. Métallurgie, xii. (1915) pp. 1-36 (52 figs.).

# PROCEEDINGS OF THE SOCIETY.

## AN ORDINARY MEETING

OF THE SOCIETY WAS HELD AT NO. 20 HANOVER SQUARE, W., ON WEDNESDAY, APRIL 19TH, 1916, MR. E. HERON-ALLEN, F.L.S., ETC., PRESIDENT, IN THE CHAIR.

**The Minutes** of the previous Meeting, having been circulated, were confirmed and signed as correct.

---

**The Hon. Secretary** having announced that the "Index Faunæ Novæ Zealandiæ," and "The Subantarctic Islands of New Zealand" (2 vols.), had been received through the High Commissioner for New Zealand, the Society recorded its thanks to the High Commissioner for this addition to the Library.

---

**Mr. Scourfield** exhibited, for Mr. H. J. Waddington, seven slides showing the development of the Ascidian *Diplosoma crystallium.* The first slide showed the interesting larval stage, looking like a diminutive tadpole; and, as the series went on, it was seen how the larva lost its tail, settled down, and gradually became an adult ascidian.

The thanks of the Society were unanimously voted to Mr. Waddington for his exhibit.

---

**Mr. Wilson** announced that he had been asked by the Committee of the Microscopical Section of the Young Men's Christian Association to invite Microscopists to assist in Microscopical exhibitions to the soldiers and sailors at the various camps within fifty miles of London. The Committee has been able to comply with only 22 out of 120 requisitions in the month of April, and at each place visited they had been invited to come again. It was desired to supply as many Microscopes as possible in order to entertain the soldiers. The three leading Microscopical Societies were co-operating, and he would be glad to receive names of those willing to help.

**The President** supported Mr. Wilson's request, and suggested that those interested in some particular line of Microscopy should send their names to Mr. Ogilvy, at the Young Men's Christian Association.

**Professor Benjamin Moore, F.R.S.**, in an address on "Early Stages in the Evolution of Life," communicated the results of some of his experimental researches. He assumed that the earliest life upon the earth must have been something in the nature of a chemical substance rather than a unicellular organism, some simple substance able to at once act upon light, which could utilize that source of energy, and by the agency of the carbonic acid of the atmosphere build up, increase, and produce other more highly organized substances and systems. Chlorophyll, which possessed many of these attributes, was much too highly complex a substance to regard as the first stage between the organic and the inorganic. He, therefore, took a quartz tube, which would transmit nearly all the rays of the spectrum, containing a simple inorganic substance, such as silica in the form of silicic acid saturated with carbon dioxide (which would have existed on the earth's surface in its very early days), and exposed it to the sun's rays. After some time he tested his solution and found that an appreciable amount of formaldehyde had been formed. Formaldehyde was the earliest substance produced by plants, and weight for weight formaldehyde had nearly as much energy as sugar.

In some concentrations formaldehyde destroyed living cells, but in a solution of one part per million Professor Moore found that certain colourless organisms could live and multiply.

He next described his experiments on the production of artificial silica growths. Silica might be regarded as a form of colloid; colloids were substances in which the simple chemical molecules were joined up in the groups of twenty or thirty, and in these groups existed possibilities for morphological groupings and changes such as he next demonstrated.

Professor Moore showed a series of photomicrograms, prepared by Mr. Barnard, of peculiar forms of growth—resembling the hyphæ of moulds—which had appeared in his masses of silica jelly, gradually solidifying in consequence of water evaporation, which had been exposed to light in glass plates, properly protected against the entrance of extraneous organisms. These structures he contended must be regarded either as inorganic, but giving the first indications towards organic structure, or else as a simpler stage of organic material.

**The President** called attention to the remarkable and as yet wholly inexplicable phenomena that had rewarded Professor Benjamin Moore's assiduous labours in a most mysterious field of biology—the border-land between the organic and the inorganic—and expressed the hope that Professor Moore would communicate the further developments to the Society as they arose. He then asked Mr. J. E. Barnard, who had been engaged with Professor Moore in this work, to open the discussion.

**Mr. Barnard** said that it was only at a relatively late stage that he had taken a part in the investigations. Professor Moore had said that a scientist was not much good unless he had imagination, and during these enquiries that truth had come home to him, because objects of this character puzzled any one to say what they were, hence one was reduced to imagining what they might be. They possessed very few of

those characteristics associated with living bodies. There was no evidence that they were organized, in the sense that they had any internal structure. The spherical ones were merely spheroidal homogeneous bodies, possessing a surface-tension envelope—i.e. there was an outside casing to them which showed a slightly higher refractive index than did the internal contents; and the whole body seemed to have a higher refractive index than the silica medium in which they lay. The change in state before the growth appeared, shown in the photographs, was perhaps the most interesting feature.

**Mr. Scourfield** asked what Professor Moore considered the dark colour of the structures seen in the photographs to be due to. It occurred to him that they might possibly be due to lines of very minute gas-bubbles.

**Mr. Hilton** compared the chain bodies described by Professor Moore with the cellulose formations of almost precisely similar appearance in the capilliitia of certain species of Mycetozoa. This was remarkable, because a plasmodium, when forming sporangia, was an albuminous colloid which was likewise concentrating into a firmer or more stable condition by depositing substances it had held in solution. In one species of Mycetozoa the capillitium thus secreted was like beaded threads, very fine, but comparatively long; and one of the slides exhibited by Professor Moore brought these slender structures very forcibly to his mind. On other slides exhibited there were wavy forms, and peculiarly branching forms, but in Mycetozoa similar forms to these also were found. In the fibrous capillitia of those organisms there seemed to be a very near approach to the structures produced by inorganic colloids which Professor Moore had shown. These latter might be regarded as inorganic counterparts of structures formed by the living colloids of Mycetozoa.

**Mr. Barnard,** replying to Mr. Scourfield, said that the visibility of such objects was dependent on the difference of refractive index between themselves and the medium. In this case an air-bubble in the medium would show up easily with a wide cone illumination. But some of these filaments were not to be seen with wide cone illumination; they needed a narrow cone. The photographs were made with a substantially smaller cone than an air-bubble could be photographed with.

A hearty vote of thanks to Professor Benjamin Moore was carried with acclamation.

---

**Mr. Martin Duncan, F.R.P.S.,** then demonstrated a very comprehensive and extensive series of photograms, stereo-photograms, micro-photograms and kinematograms illustrating his "Studies in Marine Biology," and described the apparatus and method he had adopted in his work, the details of which will be embodied in an article, illustrated by some examples of the work, to appear in the pages of the Journal.

**The President,** in proposing a vote of thanks to Mr. Martin Duncan, which was carried by acclamation, called attention to the very

remarkable results attained in the stereoscopic photographs which he had laid before the Society.

**Mr. Martin Duncan**, in acknowledging the vote, said it was a peculiar pleasure to him to stand there, where so often in the past his father had stood.

---

The following gentlemen were balloted for as Ordinary Fellows of the Society, and were declared by the President to be duly elected:— Frederick Ashworth, Professor Benjamin Moore, F.R.S., Sydney Pitt, Francis E. Robotham, Dr. Charles Singer.

**The Hon. Secretary** read the Nomination papers of the following Candidates:—Alfred Thomas Davies, Arthur Percy Wilkin.

---

**Mr. J. W. Purkiss's** paper on "Some Suggestions Regarding Visual Efficiency in the Use of the Microscope and other Optical Instruments" was postponed, owing to the lateness of the hour.

The Meeting thanked Messrs. Angus and Watson for the loan of Microscopes, and Professor Benjamin Moore and Mr. Waddington for their exhibits.

---

## AN ORDINARY MEETING

OF THE SOCIETY WAS HELD AT 20 HANOVER SQUARE, LONDON, ON WEDNESDAY, MAY 17TH, 1916, MR. E. HERON-ALLEN, F.L.S., ETC., PRESIDENT, IN THE CHAIR.

**The Minutes** of the preceding Meeting, having been circulated, were confirmed and signed by the President.

**The Hon. Secretary** announced the donation of two historical Microscopes of the Ellis aquatic type, presented by Mr. C. E. Heath, F.R.M.S., and a copy of "Practical Principles of Plain Photo-micrography," presented by the author, Mr. G. West. The thanks of the Society were accorded to the Donors.

**The President** announced the resignation by Mr. Rousselet of the office of Curator of the Society's Instruments, and, in the name of the Council and of the Society, paid a warm tribute to the excellent work which this distinguished Fellow had carried out for the Society. A very hearty vote of thanks was accorded, and ordered to be entered upon the Minutes, to Mr. Rousselet for his services to the Society.

**Mr. Julius Rheinberg** then read a paper by Mr. J. W. Purkiss, entitled "Some Suggestions regarding Visual Efficiency in the Use of the Microscope and other Optical Instruments," in which the author said that, from experience of work with the spectrophotometer and other comparative instruments for measuring colour absorptions, he had arrived at the conclusion that the observer's visual efficiency and accuracy over prolonged periods depends very largely on adjusting the light in which he was working, so that it should be approximate to the light-intensity in the field of the observing instrument. He developed this principle in its application to the Microscope and other optical instruments, and showed how the more or less rapid succession of efforts of the eye to accommodate itself to changes of luminosity was usually a much more potent cause of eye fatigue or strain than the actual conditions of light in the field of the instrument itself. This

principle was enforced by reference to the so-called temporary blinding of the eye by sudden changes of luminosity, as, for example, from—

| | | |
|---|---|---|
| 1. The sun . . . . | to | Bright daylight, |
| 2. Bright daylight . . . | .. | Interior daylight, |
| 3. Artificial illuminants themselves | .. | Interior artificial lighting, |
| 4. Interior artificial lighting . | .. | The photographer's dark room, |

although prolonged observations without strain or discomfort could be conducted in most of these kinds of lighting when the eye was not called upon to make violent adjustments by changing over from one kind to another.

**Mr. Maurice Blood** commented upon the importance of this contribution with reference to the accuracy of range-finders. The importance of keeping the luminosity of the microscopical field and that of the worker's surroundings of equal intensity had been impressed upon him by long hours of work, and his own practice was to darken the room somewhat, to cut down the illumination of the microscopical field, and, finally, the size of the field itself by means of an iris-diaphragm in the eye-piece.

**Mr. Ainslie, R.N.**, in estimating the importance of the factors affecting accuracy in the use of range-finders at sea, considered that more importance must be attributed to the motion of the ship than to varying luminosities, and, further, regarded contrasts between the colour in the field of view and that of the general light as of much more importance than variation in the intensity of the luminosity.

**Sir E. Ray Lankester** described a device by which the luminosity of an electric arc was reduced to that of ordinary diffuse day-light, and stated that the observation of an artist friend proved that such light was exceptionally useful for prolonging the hours of work when using oil colours. He inquired whether it was within the knowledge of any of the Fellows that such illumination had been used for the purpose of microscopy.

**Mr. Barnard** remarked that he had had the advantage of reading the paper in advance, and had therefore made an experiment to test the method suggested under working conditions. There was perhaps no more difficult image to focus than the fluorescent one which resulted from the use of ultra-violet light in photomicrography. If the room in which this work was being carried on was illuminated by means of monochromatic green light, as emitted by a mercury vapour lamp, it appeared to be easier to focus the fluorescent image than under any other conditions. His experimental observations in this connexion, therefore, supported the contentions of Mr. Parkiss.

A paper by the **Rev. Hilderic Friend** on "Alien Oligochæts in England" was taken as read, and will appear in full in the Society's Journal.

**The President** then read a note by Mr. Arnold T. Watson on "A Case of Apparent Intelligence Exhibited by a Marine Tube-Bearing Worm, *Terebella conchilega*," which will be published in full in the Journal of the Society.

The thanks of the Society were voted to the authors of these three papers.

**Mr. Scourfield** then announced the objects comprising the Exhibition of Pond-Life, which had been provided by Fellows and members of the Quekett Microscopical Club, and said that these May Meeting Pond-Life Exhibitions had become a constant feature of the Society's Programme, and he thought that was a very good thing. Many reasons might be given to justify the holding of such exhibitions, but they always appealed to him for the opportunity they gave for making converts to the study of fresh-water organisms, and for strengthening the faith of those who had already embarked on such study. To the non-professional worker especially the study of fresh-water organisms offered many advantages. Three of the most important of these were:—1. The comparative smallness of the number of species. 2. The comparative simplicity of the conditions of their existence. 3. The comparative ease with which they could be collected and kept alive under artificial conditions. But, although the number of species was somewhat restricted, there were, of course, a great many altogether. Even the number of groups of fresh-water organisms was very considerable, and never by any chance did they get representations of all of them at any one Pond-Life Exhibition. He had noticed in looking at the lists of exhibits for a few years past that certain groups, e.g. Peridiniaceæ, Sponges, Gastrotricha, Nematoda, Tardigrada, appeared to have been ignored altogether, and that some others, e.g. Blue-green Algæ, Suctoria, Turbellaria, had only been shown a few times. Naturally, that evening was no exception to the rule, and there were many groups of Pond-Life creatures not represented, but, on the whole, he thought it was a very good exhibition.

Mr. Scourfield proceeded to briefly refer to the actual objects exhibited according to the groups to which they belonged. In conclusion, he referred to the regret of all the Fellows at the unavoidable absence of Mr. Rousselet and Mr. Thomas Powell from among the exhibitors that evening. So far as he could remember, they had never previously failed to exhibit at a Pond-Life Meeting.

**The President** then moved from the Chair a hearty vote of thanks to the exhibitors of Pond-Life specimens, which was carried by acclamation.

---

**New Fellows.**—The following were elected Ordinary Fellows of the Society:—Alfred Thomas Davies, Arthur Percy Wilkin.

---

**The Hon. Secretary** read the nomination paper of the following Candidate, Mr. E. Marshall Hall, K.C., M.P.

**The President** then informed the Fellows of the death of Mr. C. Lees Curties, and moved from the Chair a vote of condolence to his relatives, which was passed by the Fellows and their visitors in silence.

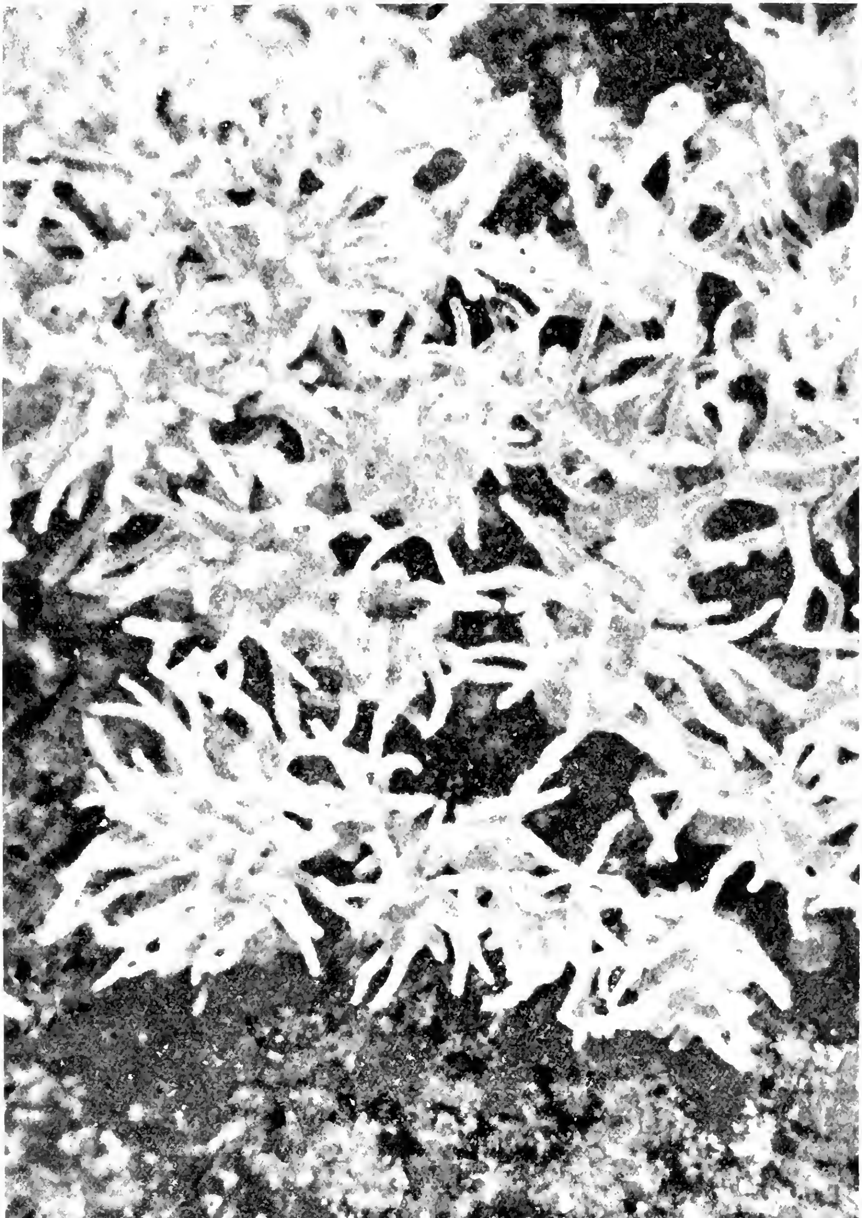
---

It was announced that the Biological Section would meet on June 7, when Mr. E. J. Sheppard would make a communication on "Mitosis and Cell Structure."

**The following Exhibits were made:—**

| | |
|---|---|
| Mr. Sydney C. Akehurst | *Asplanchna* ? sp. |
| Mr. F. W. Watson Baker | *Melicerta ringens.* |
| Mr. W. E. Watson Baker | *Floscularia regalis.* |
| Mr. E. E. Banham | *Diaptomus Castor.* |
| Mr. L. C. Bennett | Bdelloid Rotifers from moss. |
| Mr. C. H. Bestow | *Volvox globator.* |
| Mr. N. E. Brown | *Gonium pectorale.* |
| Mr. Edgar Cuzner | *Plumatella fungosa.* |
| Mr. Daniel Davies | *Hydra viridis*, showing sexual buds. |
| Mr. D. Davies, jun. | Water-mites. |
| Mr. A. Downs | *Hydra viridis*, showing sexual buds. |
| Mr. J. R. Duncanson | *Hydatina senta.* |
| Mr. W. E. Ford-Fone | *Stephanoceros eichhorni.* |
| Mr. H. E. Freeman | Larvæ of water-bugs, *Acilius sulcata* and *Corixa*; also *Daphnia pulex*, etc. |
| Mr. A. E. Hilton | Swarm-spores of Mycetozoa. *Reticularia lycoperdon.* |
| Mr. C. H. Huish and Mr. H. E. Hurrell | *Zoothamnium*, *Vorticella*, *Plumatella*, *Asplanchna Brightwelli*, *Hydra viridis.* |
| Mr. W. Lauwers | *Hydra vulgaris.* |
| Mr. J. Milton Offord | *Brachionus*, *Anuræa*, *Triarthra*, etc. |
| Mr. John Richardson | *Melicerta ringens.* |
| Mr. F. E. Robotham | *Cyclops fuscus.* |
| Mr. D. J. Scourfield | *Herpetocypris reptans.* |
| Mr. Geo. Tilling | *Volvox.* |
| Mr. W. R. Traviss | *Simocephalus vetulus.* |
| Mr. H. C. Whitfield | Tail of *Ephemera* larva. |
| Mr. J. Wilson | *Melicerta ringens.* |

In addition to the above-named Pond-Life Exhibits there were shown:—The Moginie Portable and Tank Microscopes, by Mr. H. E. Freeman, and *Drosera rotundifolia* (Sundew), with captured insect *in situ*, by Mr. C. E. Heath.



*Face p.* 361.

JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY.

AUGUST, 1916.

## TRANSACTIONS OF THE SOCIETY.

### XIII.—*The Life-history of Mycetozoa, with special Reference to Ceratiomyxa.*

By Gulielma Lister.

(*Read June* 21, 1916.)

Plates X, XI.

The true Mycetozoa—excluding the Sorophora—form a remarkably compact group of the class Sarcodina of the Protozoa. The course of the life-history is much the same in all members of the family—the spores give birth to swarm-cells; these unite and eventually form plasmodia; the plasmodium at length concentrates to form aerial reproductive bodies producing spores. The spore-bearing bodies consist usually of membranous cases enclosing spores, and are called sporangia; in one species, *Ceratiomyxa,* the stalked spores are borne on the surface of gelatinous processes, the sporophores. The former class constitutes the Endosporeæ, and contains about 260 species; *Ceratiomyxa* is the sole representative of the class Exosporeæ.

In the following notes I propose to rehearse briefly the life-history of one of the Endosporeæ, and then to compare it with that of *Ceratiomyxa.* As an example of the former class, *Badhamia utricularis* may be chosen. It is an abundant species

EXPLANATION OF PLATE X.

Freshly-formed sporophores of *Ceratiomyxa fruticulosa,* magnified about 80 times. From a photograph by J. Howard Mummery.

in many parts of this country, with conspicuous orange plasmodium that feeds on leathery fungi, and is easily cultivated indoors; the grape-like clusters of small iridescent grey sporangia may be found in favourable seasons, from the summer on into winter, hanging in quantities from the sides of fungus-grown logs in sheltered situations. At the least touch the membranous sporangium-walls break and a shower of dark spores is shed, to be carried away on the breeze, or to be washed down by rain. The spores are not, however, all shed at once, for their dispersion is checked or regulated to some extent by the "capillitium," a structure which in this species consists of a delicate network of tubules, stiffened with deposits of carbonate of lime, and attached to the sporangium-walls. When a ripe spore is moistened, the contents swell, burst the spore-wall, and emerge as a uninucleated swarm-spore or zoospore. This at first creeps about in an amœboid manner, but soon acquires a flagellum and swims. From the opposite end of the cell to the flagellum pseudopodia are extended, to which bacteria and other food particles adhere, to be conveyed into the interior of the cell and dissolved in digestive vacuoles. After feeding for some time, the swarm-cell divides, its nucleus meanwhile undergoing mitotic division. This process may be repeated several times. Dr. Jahn has proved that these swarm-cells are to be regarded as gametes; they fuse in pairs, their nuclei unite, and zygotes are formed which grow into plasmodia.* The process of fusion was not actually observed, but his cultivations showed numbers of zygotes with large single nuclei, in which when mitosis occurred he could count sixteen chromosomes, whereas the number of chromosomes in the swarm-cell nucleus is eight. The zygotes could often be distinguished at a glance by their habit of absorbing the gametes and devouring them in digestive vacuoles (Pl. XI, figs. 2, 3), while the gametes feed only on minute organisms, such as bacteria. The plasmodia, as the zygotes are termed when they begin to absorb food, increase in size also by uniting with one another. Within their substance a continual rhythmic streaming of granular protoplasm is set up, by means of which all parts are kept in communication. The plasmodium spreads out in a network of veins, searching for food, and grows rapidly; the nuclei meanwhile divide *pari passu*. Several times they have been seen to divide by mitosis simultaneously over a wide extent of plasmodium; considering the many prolonged and unsuccessful attempts that have been made to observe this process, it seems not improbable that they also sometimes divide by direct division. After a time, the length of which varies according to the amount of the food supply, or also, as Dr. Jahn has observed, as the result of cold, the plasmodium concentrates at numerous points to form

* E. Jahn (1911), Myxomycetenstudien. 8. Der Sexualakt. Ber. Deutsch. Bot. Ges., xxix. p. 231.

sporangia; sporangium-walls are secreted, and the remainder of the protoplasm, after the capillitium has been formed, divides into spores; before spore-formation the nuclei undergo a reduction division, and each daughter-nucleus forms the centre of a spore.

We may now turn to the course of events in *Ceratiomyxa* (Pl. X and Pl. XI, fig. 7). The sporophores are fragile white branching or anastomosing structures, often appearing in great abundance on the surface of much-decayed wood. The general aspect of a large development closely resembles that of a thin effused *Polyporus*. The colourless ellipsoid spores are borne on slender stalks bristling over the surface of the sporophores; they are readily detached, and are dispersed by currents of air or washed away by rain, which completely dissolves the gelatinous sporophores from which they have fallen. Notwithstanding the naked and unprotected condition of the young spores as compared with those of the Endosporeæ, *Ceratiomyxa* must be regarded as a successful species, for it is abundant in both tropical and temperate regions where decaying wood occurs. The ripe spores differ from those of the Endosporeæ in possessing four nuclei. On being moistened the spore-wall is thrown off with a jerk from the swelling of the contents; the latter at first show slight amœboid movements, and often put out pointed pseudopodia, but very soon the four nuclei divide by mitosis, and the whole cell separates successively into two, four and eight parts; each of the eight uninucleate divisions acquires a flagellum and swims off as a minute swarm-cell (Pl. XI, fig. 7, *a–h*). The further history of these swarm-cells or flagellulæ has not been traced; they have been observed to withdraw their flagella and become amœbulæ, but these have not been observed to conjugate in pairs or to form plasmodia; from analogy with the Endosporeæ however it is probable that such processes occur. Dr. Jahn was able to count eight chromosomes in the nuclei of the swarm-cells and sixteen in those of the plasmodium, showing that when the latter stage is reached the haploid nuclei have become diploid. As the plasmodium lives within rotting wood it is invisible till it comes to the surface to fructify. It then emerges in the form of transparent cushions of jelly. If such a cushion be placed on a glass slide and kept moist, the jelly is seen to be traversed by a dense network of protoplasmic veins in which rhythmic streaming of granules can be watched. The streaming was clearly observed when the shock of placing the specimen on glass had caused part of the plasmodium to gush out from the main cushion; the injured part recovered in half an hour and spread in a thin fan, in which a fine system of interlacing currents was seen; later the fan developed into a flat sporophore adhering to the glass, and formed healthy spores. Five successive stages in the development of the sporophore were distinguished by the Russian botanists, Woronin

and Famintzin, in their classic work on *Ceratiomyxa*.* (1) The *cushion* stage already described. From the cushions finger-like processes grow in (2) the *expansion* stage. In these the plasmodium forms at first a sponge-like network, but as they attain their full length the network concentrates on the surface and forms there an enveloping layer; this is (3) the *network* stage. The network divides up to form (4) a mosaic of cells, which completely covers the upper part of the gelatinous sporophore, and is more loosely distributed in the lower part; this *mosaic* stage soon passes into (5) the *spore-bearing* stage, when each cell pushes outwards and grows into a long-stalked spore. It is at the beginning of the network stage that Dr. Jahn discovered that all the nuclei of the plasmodium undergo a reduction division.† Preparations kindly lent to me by him show nuclei in all stages of mitosis in rather stout strands of protoplasm measuring 11–17 $\mu$ across (Pl. XI, fig. 6 *a–d*). When a little later the network has become closer and its strands more slender the daughter-nuclei have already separated. A certain number of the latter stain very darkly and degenerate, and are often to be seen in stainings of young spores lying beside the perfect nucleus (Pl. XI, fig. 6 *f*). It is probable that we see here "a process of elimination" (to use Professor Minchin's words ‡) "of effete or negative chromatin preceding the formation of the gametes

* M. S. Woronin and A. S. Famintzin (1873) "Ueber zwei neue Formen von Schleimpilzen." Mém. de l'Acad. Imp. Petersbourg, sér. 7, xx. p. 4.

† E. Jahn (1908), Myxomycetenstudien. 7. *Ceratiomyxa*. Ber. Deutsch. Bot. Ges., xxvi. d. p. 342.

‡ Minchin (1912), "An Introduction to Protozoology," p. 142.

---

## EXPLANATION OF PLATE XI.

Figs. 1–3.—*Physarum didermoides* (Ach.) Rost.
,, 4–5.—*Didymium squamulosum* (A. & S.) Fries.
Fig. 7. —*Ceratiomyxa fruticulosa* (Muell.) Macbr.

Fig. 1.—Swarm-cell: *a*, with resting nucleus; *b*, with dividing nucleus.
,, 2.—A zygote or young plasmodium, with a single nucleus undergoing mitotic division, and a digestive vacuole which contains the remains of a swarm-cell.
,, 3.—Young plasmodium, with two nuclei; *a* shows a digestive vacuole containing food.
,, 4.—Ditto, with three nuclei; a swarm-cell lies beside it.
,, 5.—Ditto, with five nuclei.
,, 6.—Strand of protoplasm from the *network* stage of the young sporophore, showing in *a*, resting nuclei; in *b*, *c*, nuclei dividing; in *d*, *e*, daughter-nuclei separated; *e* is from a late *network* stage; *f*, cells from *mosaic* stage. In *c*, *d*, *e*, *f*, darkly-staining degenerate nuclei are seen.
,, 7.—*a*, Ripe spore, with four nuclei; *b* to *e*, spore contents dividing; *f*, group of eight young swarm-cells just acquiring flagella; *g*, *h*, swarm-cells, with lengthening flagella.

All the figures on this plate are drawn from preparations made by Dr. E. Jahn; magnified 930 times.


[Face p. 364

or their nuclei." In the mosaic stage each cell contains a single nucleus which passes into the young spore, where it undergoes two mitotic divisions *; thus the four nuclei of the mature spore are produced.

We may briefly review the development of *Ceratiomyxa*, and compare it with one of the wood-inhabiting species of the Endosporeæ. In both the plasmodium emerges in the form of cushions of jelly to fructify in the open air. In both the nuclei undergo a reduction division before spore-formation. By a stretch of imagination, the sporophore in the mosaic stage might be regarded as a sporangium with an evanescent or undeveloped wall, and with a large gelatinous columella, over whose surface the spore-cells form only a single layer. But after this stage all attempts to make the two life-histories correspond fail. In the outgrowth of the spore-cells to form stalked spores *Ceratiomyxa* shows a unique arrangement; moreover, in these spores a remarkable process of what may be called precocious development occurs, by which each mature spore contains four nuclei, and these, on germination, at once divide again to take charge of the eight flagellulæ into which the spore-contents separate. In the Endosporeæ the increase of eight flagellulæ from one spore is arrived at leisurely and after repeated intervals of feeding. Thus although *Ceratiomyxa* is undoubtedly one of the true Mycetozoa, it holds a curiously solitary position, apart from all other species of the group.

In conclusion I wish to express my indebtedness to Dr. Jahn for his courtesy in lending me the preparations from which the drawings on Pl. XI were made. I have also to thank Mr. J. H. Mummery for allowing his beautiful photograph of *Ceratiomyxa* to be reproduced on Pl. X.

* These divisions are well illustrated by E. W. Olive (1907), "Cytological Studies in *Ceratiomyxa*." Trans. Wisc. Acad. Sci., xv. pl. xlvii. figs. 11–14.

# SUMMARY OF CURRENT RESEARCHES

RELATING TO

# ZOOLOGY AND BOTANY

(PRINCIPALLY INVERTEBRATA AND CRYPTOGAMIA),

# MICROSCOPY, ETC.*

## ZOOLOGY.

### VERTEBRATA.

#### a. Embryology.†

**Transition of Peritoneal Epithelial Cells into Germ-cells in some Amphibians.‡**—J. Bronté Gatenby has studied the ovaries of frogs and toads throughout the year, and maintains that the epithelium surrounding the ovary is truly germinal. During life very large reinforcements of germ-cells arise in the epithelium of the gonad, and transition stages between peritoneal cell and germ-cell are figured. Germ-thickenings in the peritoneal epithelium surrounding the ovary appear in early spring. They become ovariform germ-pockets containing newly formed germ-cells in all stages.

The intermediate stages between peritoneal cell and germ-cell consist primarily in the elimination of a greater part of the chromatic matter of the nucleus, in the appearance of a granular zone in the cytoplasm which becomes totally granular and stains more heavily than before, and finally in the appearance of several nucleoli subsequent upon a loss of the regular shape of the nucleus.

Thickenings containing many thousands of germ-cells, and larger than the entire ovary of a lately metamorphosed frog, have been found, especially in May. Reasons are given why the cells composing the germ-thickenings in the ovary are not to be considered stored-up germ-cells.

The ovary of a tadpole is formed of (1) germ-cells of peritoneal

* The Society are not intended to be denoted by the editorial "we," and they do not hold themselves responsible for the views of the authors of the papers noted, nor for any claim to novelty or otherwise made by them. The object of this part of the Journal is to present a summary of the papers *as actually published*, and to describe and illustrate Instruments, Apparatus, etc., which are either new or have not been previously described in this country.

† This section includes not only papers relating to Embryology properly so-called, but also those dealing with Evolution, Development, Reproduction, and allied subjects.

‡ Quart. Journ. Micr. Sci., lxi. (1916) pp. 275–300 (2 pls. and 5 figs.).

origin; (2) germ-cells of retro-peritoneal origin; and (3) germ-cells of endoderm (yolk-sac) origin. The germ-cells derived from the yolk-sac may possibly all be laid during the first spawning. Through the peritoneum the mesoderm supplies by far the greatest number of germ-cells. The peritoneal cell always remains in a sufficiently undifferentiated state to metamorphose, if needed, into a germ-cell. The changes undergone in the differentiation of an oogonium into an oocyte are more important and extensive, as far as the nucleus is concerned, than those of the peritoneal cell when becoming a germ-cell. There is no continuity of germ-cells in frogs and toads at least.

**Intra-uterine Eggs of Heterodontus (Cestracion) philippi.***—W. A. Haswell describes the segmentation observed in uterine eggs of this shark. The lines of cleavage are confined to the area of the "orange-spot." A sub-elliptical blastoderm presents the appearance on a surface view of an irregular ring of larger cells separated from one another by fissures having a radial arrangement, and surrounding an area of smaller cells of great irregularity in size and shape. A later stage shows a segmentation cavity beneath the blastoderm. Later on, the segmentation cavity has become a large space below the posterior end of the blastoderm, with a thin roof through which the cavity shows itself as a dark area in the living egg. In regard to the red colouring matter which produces the "orange-spot" in Elasmobranchs, it is suggested that it may play the part of a respiratory pigment aiding in the oxidation of the massive blastoderm and the underlying parablast.

**Infection of Hens' Eggs.†**—Philip B. Hadley and Dorothy W. Caldwell found out of 2520 fresh eggs that 8·7 p.c. showed bacterial infection in the yolk. None of the 111 whites examined showed infection, and the yolks of the same eggs gave a percentage slightly less (4·5) than the average of this series (7·7). The percentage of infection obtained for individual hens per year varied between 2·8 and 15, the average being 9. No hen laid exclusively sterile eggs during any full year. No correlation was observed between percentage of infection and "hatchability," nor between percentage of infection and fecundity, age of the birds, or the season of the year. The percentage of infection for unfertile and for fertilized eggs was essentially the same. The bacterial types from one series consisted of eleven cocci, twenty-eight rods and one spirillum.

The most probable source of primary infection is in the ovaries of the fowl, which become infected by bacteria escaping from the intestine into the portal circulation. The primary infection plays no *rôle* in bringing about the decomposition of eggs. For the factors determining decomposition secondary infections must be looked to. The nature and extent of the ordinary primary infection stands in no causal relation to embryo-mortality in incubating eggs, and losses in "dead-in-shell" embryos cannot be explained on these grounds.

* Quart. Journ. Micr. Sci., lxi. (1916) pp. 313–6 (2 figs.).
† Agric. Exper. Stat. Rhode Island, Bull. No. 164 (1916) p. 1–70.

**Double-yolked Eggs.***—Maynie R. Curtis has made a study of double-yolked eggs in hens. In one type (16·03 p.c.) there is an entire set of egg envelopes common to the two yolks; in a second (70·99 p.c.) the chalaziferous layers are separate, but all or part of the thick albumen is common to the two yolks; in a third (12·98 p.c.) the yolks have entirely separate thick albumen envelopes, but a common egg membrane and shell. There are many gradations within and between these groups.

It is probable that the two components of the double-yolked egg unite at any level of the oviduct from the funnel mouth to the isthmus ring, and thus different types arise. In 36·44 p.c. of the double-yolked eggs the ovulations which furnished the two yolks must have been separated by an abnormally short interval, since a normal egg had been laid on the preceding day. Examination showed that the two yolks have passed the entire length of the duct together in only 16·28 p.c. of the cases in which ovulations are known to have been unusually rapid. Only in a small percentage of double-yolked eggs is there any evidence of simultaneous ovulation. The fusion of follicles and a resulting common blood supply is by no means the usual cause for the production of a double-yolked egg. The occurrence of double-yolked eggs may indicate heightened fecundity or a low physiological tone of the oviduct.

**Pituitary Extract and Ovarian Activity.**†—Raymond Pearl and Frank M. Surface have previously shown that the substance of the corpora lutea of the cow has the power to inhibit ovulation in an actively laying fowl. They have sought for some other substance that would activate the resting ovary. Then it would be possible to start and stop a hen's egg-laying activities at will. The connexion of the pars anterior of the pituitary body with the genital organs has been proved, and extract of pituitary body was experimented with. But the injection of the substance into the abdominal cavity of hens, in which the ovary was in a completely resting condition, did not cause any activation of the ovary, in the sense of inducing ovulation at an earlier date than that at which it would normally occur.

**Sex-changes in a Cow.**‡—Raymond Pearl and Frank M. Surface describe the assumption of male secondary characters by a cow with cystic degeneration of the ovaries. The cow was initially a perfect female, bearing calves, and making a very high milk record. Later she failed to come on heat, and gradually, but finally to a very marked degree, took on male secondary characteristics, both in behaviour and structure. The bull characteristics were best seen in the neck, which developed a well-marked crest. The udder shrunk to a very small size. The hips and rump took on the smooth, rounded, filled-out appearance which is characteristic of the bull.

* Journ. Agric. Research, iii. (1915) pp. 375–86 (7 pls.).
† Journ. Biol. Chemistry, xxi. (1915) pp. 95–101.
‡ Rep. Maine Agric. Exper. Stat., 1915, pp. 65–80 (10 figs.). See also Science, xli. (1915) pp. 615–6.

The gonads were normal, save that the follicles were not breaking and discharging ova, but were forming follicular cysts, or becoming atretic, and because of this no corpora lutea were formed. The interstitial secreting tissue was normal. The evidence suggests that one function of the corpus luteum, through its internal secretion, is to maintain in full development the female secondary sex characters. Repeated injection of a suspension of the desiccated substance of the anterior lobe of the pituitary body failed to bring out any change in the sex behaviour of this cow after it had assumed its masculine appearance.

**Abnormal Oviduct of Hen and its Consequences.***—Maynie R. Curtis describes a case where the oviduct ended blindly below the isthmus, there being no shell gland or vagina. Yet the oviduct apparently functioned as far as the passage existed, whence the eggs were returned to the body-cavity and absorbed. Over a score of eggs and empty egg membranes were removed from the body-cavity. As the bird was in good flesh and apparently normal in all ways but one, it is plain that the absorption of a large quantity of its own proteins from the peritoneal cavity does not necessarily cause metabolic disturbances.

**Peritoneal Canals in Bird Embryos.†**—J. H. Tuntler has found in chick embryos from the fourth day two blind peritoneal canals on the sides of the gut after this has reached the anterior peritoneal wall. In the peritoneal canal and on the ventral aspect of the adjacent portion of the cœlom, a peculiar glandular papillary organ is formed, which disappears by the ninth day, except as regards a longitudinal epithelial ridge or two of them in the peritoneal canal, lasting till the twelfth day. The lining cells of the peritoneal canal are at first rather epithelium-like; they become by the eleventh day endothelial. A cellular strand from the end of the peritoneal canal becomes a muscle (m. retractor peritonei); on the twelfth day it is no longer in connexion with the canal, but extends to the cloaca. In duck embryos the observer found peritoneal canals, the papillary peritoneal organ, and the cellular stage of the m. retractor peritonei. The peritoneal canals described are doubtless homologous with those in Chelonians and crocodile.

**Experimental Mesothelium.‡**—W. C. Clarke has inquired experimentally into what occurs after an injury destroying the free surface cells of the peritoneum or pleura, or the lining cells of blood-vessels. Do cells grow at the periphery of the denuded area, taking origin from adjacent, previously existing and intact flat surface cells? Or do the exposed connective tissue cells of the floor of the injured area proliferate and become flattened?

It was found that the subcutaneous connective tissues react to the presence of a smooth-surfaced, non-irritating foreign body, celloidine in the experiments, in such a manner that there results a distinct pavement

* Biol. Bulletin, xxviii. (1915) pp. 154–62 (2 pls.).
† Tijdschr. Nederland. Dierk. Ver., xiv. (1915) pp. 1–36 (3 pls. and 1 fig.).
‡ Anat. Record, x. (1916) pp. 301–16 (11 figs.).

layer of flattened cells, the outlines of which are demonstrable by the impregnation of their intercellular substance with a silver salt. The tissues of the cornea, free from blood-vessels, in contact with paraffin form similar flattened cells.

The experiments show after repair is complete that the free surface cells of accidental spaces in the tissues are flattened and form a pavement. It follows that the second of the hypotheses mentioned above is tenable. The flat cells of serous surfaces and those lining blood-vessels may regenerate from deep connective tissue cells, and do not necessarily arise from adjacent intact mesothelial or endothelial cells.

**Development of Pacific Herring.***—C. McLean Fraser describes the spawning habits and development of *Clupea pallasii*, the Pacific herring. The spawning occurs but once in a year, and occurs near shore among bladder-wrack and eel-grass. After all sorts of enemies, such as birds and fishes, have had an abundance, there would probably be a million eggs left to every square foot. The segmentation of the egg and the general development of the various organs are dealt with. In another paper † the author discusses paternal care in the Blue Cod (*Ophiodon elongatus*), the behaviour of the young Dog Salmon (*Oncorhynchus keta*), the diagnosis of fishes by means of their scales, and other points.

**Regeneration of Tail in Lizard.**‡—C. P. White has studied regeneration after autotomy in *Lacerta vivipara*, and finds that there is no special autotomy-site, for apparently any vertebra may be involved. Autotomy takes place through the middle of the vertebra. In a fully regenerated tail are found: (1) the skin and subcutaneous tissue; (2) sixteen longitudinal bundles of muscles, segmented in zig-zag rings; (3) fatty connective tissue in which run nerves and blood-vessels; (4) in the centre a tube of cartilage, unsegmented and continuous except for some perforations through which blood-vessels pass into the interior; and (5) an epithelial tube continuous with the central canal of the spinal cord, just as the cartilaginous tube is continuous with the body and neural arch of the vertebra through which the fracture has occurred.

After autotomy the wound is quickly covered with new skin, beneath which is a mass of spindle-cells originating apparently in the connective tissue. This acts as a growing point, and cartilage, fat, and blood-vessels arise from the spindle-cells. The muscle-fibres arise segmentally in groups, the groups nearest the tip being least differentiated. The muscles in the stump play no part. The nerve-trunks in the autotomy-wound elongate as the regeneration proceeds. The central canal reaches to the extreme tip of the tail just beneath the skin; it there loses itself in the surrounding cells, and is apparently developed from them; it has no connexion with the epidermis.

* Trans. Roy. Canadian Inst., xi. (1915) pp. 97–108 (2 pls.).
† Trans. Roy. Canadian Inst., xi. (1915) pp. 109–18 (1 pl.).
‡ Rep. Brit. Assoc. Manchester, 1916, pp. 472–3.

*b.* Histology.

**Discession of Chromosomes and Mitokinetism.***—Marcus Hartog has previously sought to show that the phenomena of the cell-spindle may be interpreted as the expression of a field of dual force, centring on the centrosomes as opposite poles, on the assumption that the achromatic fibres are more permeable to the force than their surroundings, and lie along the lines of force whose distribution they, of course, modify. The chromosomes are also more permeable, and may be termed "flexible inductors." Further experimentation has led him to a view which explains the discession of the chromosomes in congruence with the theory outlined.

**Comparative Study of Vermiform Appendix.**†—W. C. Mackenzie finds that man, ape, wombat, and *Echidna* have a true vermiform appendix. Various grades of degeneration of the appendix of *Echidna* occur. In the wombat it may entirely disappear, by incorporation in the wall of the ileum. In *Ornithorhynchus* there is a cæcum.

**Spleen of Carnivores.**‡—Ed. Retterer and H. Neuville have investigated the structure of the spleen in various Carnivora. In the bear and the lion there is a syncytium surrounding the splenic arterioles, not a reticulum with meshes containing free lymphocytes. This syncytium represents the first stage in the evolution of the splenic parenchyma. It is traversed by granular anastomosing filaments, and not by collagenous or connective fibres. The syncytium represents germinative centres, and is transformed into reticulate tissue with empty meshes. By the disintegration of the reticulum the cellular remains become free as leucocytes, and if the nucleus has undergone hæmoglobic-degeneration it becomes a red blood-corpuscle.

**Spleen of Cetaceans.**§—Ed. Retterer and H. Neuville give an account of the structure of the spleen in some Delphinidæ (dolphin, porpoise, *Orca gladiator* and *Grampus griseus*). In relation to the rest of the body the spleen is small. The splenic mass is divided in multiple lobes which are quite distinct. It is not merely that there are incisions, as in many Mammals; each lobe is enveloped in a distinct connective muscular tunic.

**Minute Structure of the Spleen.**‖—Ed. Retterer has studied the vascular reticulum of the spleen in various types of Mammals. After passing into lacunæ without proper walls, the splenic arterioles continued into canals (venous radicles) whose reticulate wall is formed of stellate splenic cells, disposed concentrically to the lumen. The vascular reticulum of the spleen is identical, as regards origin and structure, with the sinuses and lacunæ of lymphatic ganglia.

* Rep. Brit. Assoc. Manchester, 1916, pp. 470–1.
† Rep. Brit. Assoc. Manchester, 1916, p. 472.
‡ C.R. Soc. Biol. Paris, lxxviii. (1916) pp. 557–61.
§ C.R. Soc. Biol. Paris, lxxix. (1916) pp. 60–4.
‖ C.R. Soc. Biol. Paris, lxxix. (1916) pp. 124–8.

**Hæmatoblasts.***—Ed. Retterer discusses critically Hayem's conclusions on the origin of blood-corpuscles, and maintains that Hayem's hæmatoblasts or blood-platelets are due to the disintegration of the cytoplasm of cells of fixed origin. They are incapable of progressive development, and continue to disintegrate or to dissolve, having in fact a very ephemeral existence. In the spleen, as in the lymphatic ganglia, there is an elaboration of plasma, red blood-corpuscles, leucocytes and platelets.

**Kurloff's Bodies.**†—Sadi de Buen has made a careful study of these minute bodies found in the mononuclear leucocytes of the guinea-pig. They have been interpreted in various way, as plasmosomes by Ferrata, as products of secretion by Kurloff, Ehrlich and Ciaccio, as parasites by Schilling, Patella, Goldhom, and Ross; and these views are all discussed. The author favours the interpretation given by Cesaris-Demel that they are included bodies. They appear to be either extraneous bodies included in a defensive process, or dead cellular residues which have been similarly engulfed.

**Phagocytosis in Urine.**‡—Ch. Hollande and J. Beauverie find in acid urine, rich in albuminoid substances, living polynuclear neutrophilous leucocytes. Outside of the organism, and at laboratory temperature, these leucocytes are able to incorporate foreign elements accidentally present in the urine, such as yeasts, bacteria, starch grains and carmine particles. Phagocytosis may occur ten hours after the urine was passed.

### c. General.

**Serum of a Guinea-chicken Hybrid.**§—Raymond Pearl and John W. Gowen record that there is a definite, characteristic, and permanent difference between the refractive index of the serum of the fowl (*Gallus*) and that of the guinea-fowl (*Numida meleagris*). The mean was taken of the data from ten fowls and six guinea-fowls. In the genus-hybrid (*Gallus* ♂ and *Numida* ♀) the guinea-parent is dominant in respect of the physico-chemical constitution of the blood as measured by the refractive index.

**Relict Species.**‖—Sven Ekman discusses the questions concerned with relict species. In a given area a species may be called a relict only when its existence there is unintelligible apart from the hypothesis that it or its ancestral species was left there in the course of natural conditions now foreign to the area. One may speak of glacial relicts, tertiary relicts, marine relicts, freshwater relicts, and so on. They are to be distinguished from auto-immigrants which have come in from without

* C.R. Soc. Biol. Paris, lxxix. (1916) pp. 57–60.
† Boll. Inst. Nacional Higiene, xii. (1916) pp. 1–16 (2 pls.).
‡ C.R. Soc. Biol. Paris, lxxix. (1916) pp. 34–6.
§ Proc. Soc. Exp. Biol. and Med., xii. (1914) p. 48.
‖ Arkiv. f. Zool., ix. (1915) No. 17, pp. 1–35.

under existing conditions, and from pseudo-relicts which migrated when the area was accessible in a way in which it no longer is. A glacial relict must be a stenothermal inhabitant of cold water, not cosmopolitan in distribution, and it must occur in an area where the previous occurrence of glacial conditions is demonstrable.

**Relations of Parasite's Phylogeny to that of Host.***—Launcelot Harrison maintains that in the case of total obligate parasites, closely related forms will be found on phyletically related hosts, without regard to other œcological conditions.

Like Kellogg, he bases his case chiefly on Mallophaga, but there is other evidence. The Anopluran genus *Pediculus* is represented on man, on Simiidæ, and on *Ateles* alone among Cebidæ; the closely related genus *Pedicinus* occurs on lower monkeys. Similarly, the parasitic Platyhelminths of a given type have their nearest relatives in a host phyletically related to theirs.

Many Mallophaga have a world-wide distribution, but always on closely related birds. Thus *Philopterus lari* occurs on all gulls; *Lipeurus anatis* on all ducks; *L. columbæ* on all pigeons; *Colpocephalum flavescens* on all hawks. The genus *Tetrophthalmus* lives in the gular pouch of pelicans, and has its tracheal system specially modified in relation to its peculiar habitat. Species of *Tetrophthalmus* occur on all pelicans, in the same situation, and are all similarly modified. The only reasonable explanation is that the parasites have had a common origin.

In their equable conditions the Mallophaga have not evolved as rapidly as their hosts. The *Philopterus* of the European cuckoo is with difficulty separable from species from the Australian genera *Cacomantis* and *Chalcococcyx*.

## INVERTEBRATA.

### Arthropoda.

#### α. Insecta.

**Germ Cells of Hymenoptera.**†—R. W. Hegner has made a series of studies on protoplasmic differentiation in the oocytes of Hymenoptera. The first deals with the differentiation of the oocytes and nurse cells in the ovaries of the hive-bee. Four regions may be recognized in the ovariole of the queen honey-bee: (1) the terminal filament; (2) a rosette region; (3) a zone of differentiation; and (4) the posterior part, in which the oocytes form a linear series separated from each other by groups of nurse cells. The rosette region is filled with rosette-like groups of cells, each group consisting of the descendants of a single mother oogonium. The cells of a rosette are united by strands which are the persisting spindle fibres from earlier mitoses. The cells in a rosette divide synchronously. Oocytes and nurse cells are both derived

* Rep. Brit. Assoc. Manchester, 1916, pp. 476–7.

† Journ. Morphology, xxvi. (1915) pp. 495–560 (13 pl.).

from the oogonia. Their differentiation occurs in the zone of differentiation. One of the cells of each rosette enlarges and becomes an oocyte, or more than one may do so. The others retain more of their earlier characteristics and become nurse cells. Although the strands which connected the cells in a rosette disappear, the descendants of a single oogonium may still be determined because of the presence of deeply staining rings between the cells. Granules appear near the nucleus of oocytes shortly after their differentiation; they are subsequently distributed throughout the egg cytoplasm; they appear to be mitochondrial in nature, and to arise from or under the influence of the nucleus.

The ovarioles of *Camponotus* consist of four distinct regions: (1) a terminal filament; (2) a terminal chamber; (3) a zone of growth free from bacteria-like rods; and (4) the posterior part, in which the oocytes are arranged in a linear series, are accompanied by nurse cells, and are surrounded and later invaded by the bacteria-like bodies. These occupy definite regions of the ovariole. They are absent entirely from the terminal filament, terminal chamber and first zone of growth. In the rest of the ovariole they occur everywhere except in the nurse cells. The oocyte is at first free from them, but later is invaded by them and almost completely filled. The rods are arranged at first in bundles, but are afterwards scattered. As the oocyte increases in size and yolk-formation proceeds, they gradually disappear until none are visible except near the periphery in the posterior region. Secondary nuclei appear near the oocyte nucleus at an early stage of growth. They increase in number, finally completely surrounding the germinal vesicle. They are afterwards distributed throughout the oocyte, especially near the follicular epithelium. Their origin by budding from the oocyte nucleus, or by the immigration of epithelial cells seems improbable. The conclusion is reached that the oocyte nucleus gives off materials into the cytoplasm which become enclosed by a membrane and develop into nuclear-like bodies. The fate of the secondary nuclei was not determined.

The chromatin in the oocyte nucleus of *Copidosoma gelechiæ* forms chromosomes at an early stage in the growth period. These chromosomes unite near their ends in pairs, and then become arranged in a parallel series upon an asterless spindle. Condensation then occurs and an apparently homogeneous oval-shaped mass of chromatin is formed. The number of pairs of chromosomes is eleven or twelve. The germ-line determinant is not the chromatin from an oocyte nucleus, as the author previously stated; it appears to be a differentiated part of the protoplasm which arises at an early stage near the posterior end of the oocyte.

The oocyte nucleus of *Apanteles* has a history similar to that described for *Copidosoma*; chromosomes are formed at an early period, fuse in pairs, become arranged upon an asterless spindle, and undergo condensation. Secondary nuclei make their appearance in the almost fully grown oocytes. They are distributed throughout the anterior part of the oocyte, but are entirely absent in later stages. Their origin and fate were not determined. The deeply staining substance at the posterior end of the older oocytes is probably a germ-line determinant. It first

appears in a partially grown oocyte as a dark granular mass, which probably represents a differentiated part of the protoplasm.

In gall-flies the history of the oak-knot gall-fly (*Andricus punctatus*) resembles very closely that of *Copidosoma* and *Apanteles*. The oocytes of the blackberry-knot gall-fly (*Diastrophus nebulosus*) contain a chromatin body which probably results from the condensation of chromosomes, as in the other forms described. A conspicuous germ-line determinant is also present near the posterior end. The follicle cells divide by mitosis. The half-grown oocytes of the mealy-rose gall-fly (*Rhodites ignota*) are provided with hundreds of secondary nuclei, which are all situated in a single layer equidistant from the periphery at all points. In younger oocytes these secondary nuclei appear to arise near the periphery from granules which stain like chromatin. These granules may be extruded by the oocyte nucleus, the follicle cells, or the nurse-cells.

**Note on Myrmecophily.*** — W. C. Crawley points out that the myrmecophilous beetle *Claviger testaceus* is sometimes found resting on the queens in nests of *Lasius flavus*, the normal host, but that the queens of *L. umbratus* appear to possess a much stronger attraction for them. When a few beetles were put into nests containing *L. umbratus* queens they clung to them and never seemed to change their resting-place for weeks. It is probable that the parasitic queens (*L. umbratus*, *L. fuliginosus*, and others) have a body-secretion which renders them attractive to other species of ants and to Myrmecophiles.

**Polymorphism in Insects.†**—A. Berlese has made an elaborate analysis of the different forms of polymorphism in insects. He deals first with individual polymorphism (Heteroidia), which may be in the same individual at the same time (asymmetry), e.g. gynandro-morphism, or at different times as in metamorphosis, or between different individuals as in the contrasts of males, females, hermaphrodites, sterile individuals, and young individuals.

The polymorphism may also be collective (Heterogonia); and here Berlese distinguishes between sexual dimorphism, synchronous castes, heterocronous castes, periodic polymorphism with the castes in different surroundings, and permanent polymorphism (for an indefinite time) with the castes or varieties in different surroundings.

Berlese deals in this paper with individual polymorphism in particular, and illustrates his views with some ingenious diagrams. Polymorphism between individuals affects size, organization, coloration, and the like. It points to lability and superfluity. It may be hypertelic, which means transcending the (entelic) mean, or hypotelic or atelic, which implies the reduction or absence of a feature possessed by the mean of the stock. Individual polymorphism is mainly due to changes in environment, especially in the nutritive conditions.

* Ann. Nat. Hist., xvii. (1916) pp. 377–8.
† Redia, xi. (1916) pp. 211–38 (3 figs.).

**Olfactory Structures in Insects.***— E. W. Roberts calls attention to the rich innervation of the epidermis in insects. Sensory cells of a generalized type are very common. Some fibrils within the cell arise directly from small bodies in the outer end of the cell, which in their turn arise from division of the centrosphere. Other fibrils lie in the walls of the cell in the chitin matrix. Their terminals are always naked and exposed, no matter how heavy the chitin may be around them.

The sensory cells of the epidermis may be sunk below the surface, as in Hicks' vesicles, or compounded into pore-plates beneath or flush with the surface, or raised into variously formed spines, scales, hairs, and pegs. But the general structure remains the same as that indicated above. The author's conclusion is that many types of epidermal cells widely scattered over the body are normally susceptible to olfactory stimuli.

**Elytral Tracheation of Tiger-beetles.**†—V. E. Shelford has made a comparative study of the tracheation in the elytra of a large number of Cicindelidæ. The two walls of the sac-like elytron are held together by chitinous pillars or columns. Setæ are almost always present, and the elytra of many species are marked by pits which are usually over the centre of the chitinous columns. There are sometimes thickenings running lengthwise of the elytron (as in *Domica*), and while these run parallel with the trachea they are usually between rather than coincident with them (except in *Caledonica*). The six main tracheal trunks common in insects are represented in but two genera (*Amblychila* and *Mantichora*), which have rudimentary wings and specialized elytra fastened together in the adult. The peculiarities of the different groups of the family as regards tracheation of the elytra are briefly stated and fully illustrated. There is in the family as a whole a tendency to reduce the anal. It is shown conclusively that tracheation is far from haphazard, but of more or less constant taxonomic significance.

**Larvæ of Furniture-beetles.**‡—James W. Munro has done a very useful piece of work in describing and contrasting the larvæ of the furniture-beetles. They belong to the two families Anobiidæ and Lyctidæ. Of the Anobiidæ four or more species are more or less common in houses and other buildings—*Anobium domesticum* and *Ptilinus pectinicornis*, most commonly found in furniture; *A. paniceum*, in stored goods; and *Xestobium lineatum*, in heavier timbers, e.g. rafters. A fifth species, *Ernobius mollis*, is rarely found indoors, but the author has two records from spruce flooring-boards and from old rafters. It is usually found under the bark of large paling posts or other coniferous timber. The family Lyctidæ includes *Lyctus canaliculatus* and *L. brunneus*, both found in stored timber, furniture, and in walking-stick and umbrella handles.

The larvæ are well adapted to their life. They are soft fleshy

* Trans. Amer. Micr. Soc., xxxiv. (1915) pp. 284–90 (6 figs.).
† Trans. Amer. Micr. Soc., xxxiv. (1915) pp. 241–52 (6 pls.).
‡ Proc. Roy. Phys. Soc. Edinburgh, xix. (1915) pp. 220–36 (2 pls. and 9 figs.).

grubs, with a hard chitinous head sunk in the first segment of the body. The mandibles are powerful. The body is curved in relation to the larva's method of progressing by alternately extending and distending, pressing on the sides of its tunnel. In the Anobiid types this is helped by spinules. The legs are very feeble. The antennæ are much reduced and sunk in pits, except in the Lyctid type. No eyes were seen. The various larvæ are dealt with in accurate detail.

**Life-history of Tachinarians.*** — W. R. Thompson discusses the intra-muscular stage in the development of *Plagia trepida* Meig. and *Sturmia scutellata* Rond. The eggs of *Plagia*, containing larvæ ready to hatch out, are laid on the body of the host. The larva traverses the skin, and entering the general cavity passes thence into a muscle, where it remains till the end of the primary stage. It then forms a secondary tegumentary air-hole, in connexion with which it passes the second and third stages. It leaves the host before pupation.

The eggs of *Sturmia* are laid on the leaves which the host eats. Devoured by a caterpillar, the eggs hatch in the alimentary canal, and the larvæ pass out into the general cavity and thence into a muscle. It applies its stigmata against a bunch of its host's tracheæ near a stigma and forms a sort of tracheal sheath, within which it remains until the end of the third stage.

The muscles react differently in the two cases. In the case of *Sturmia*, a simple cutaneous muscle becomes a large lobed sac with thick walls. Striations and fibrils disappear; the size of the nuclei increases, and their number as well (apparently by direct divisions); the chromatin breaks up into a mass of fine granulations.

In the case of *Plagia* there are no striking changes for some time. Thus the striations persist. The final change takes place somewhat suddenly, death and disintegration taking place rapidly. The substance of the muscle is used up by the parasite. In *Sturmia* there is hypertrophy of a living fibre; in *Plagia* there is breaking up of a dead fibre. Phagocytes are few or absent around the fibre in *Sturmia*; they are numerous, naturally enough, in *Plagia*, where they are doubtless attracted by chemotaxis.

When it enters a muscle the larva of *Plagia* is much larger than that of *Sturmia*; its initial mechanical effect is more violent. At the end of the first stage the proportions are reversed. The growth of *Sturmia* in the first stage is much greater than that of *Plagia*, and the duration of the stage is much greater. The salivary secretion of the larva is more abundant in *Sturmia* than in *Plagia*, and the salivary glands are larger, especially towards the end of the first stage.

**Life-history of a Nycteribiid.†** — J. Rodhain and J. Bequaert discuss the life-history of *Cyclopodia greeffi* Karsch, parasitic on a Congo bat (*Cynonycteris straminea*). The insects often remain for hours motionless on their host; they suck blood at frequent intervals; they

* C.R. Soc. Biol. Paris, lxxviii. (1915) pp. 717–21 (5 figs.).
† Bull. Soc. Zool. France, xl. (1916) pp. 248–62 (4 figs.).

die rapidly if isolated, but the young forms just hatched from the pupa stage can survive for a day or so. After insemination the female leaves the bats and runs rapidly on adjacent objects (on the cage), and deposits a larva which she presses against the substratum. She then returns to her host. In natural conditions the larvæ are probably deposited on the branches. After two to six days a female may liberate another larva. The newly laid larva shows eleven segments and two pairs of stigmata. The pupa hatches in twelve to sixteen days. The reproductive organs of the imago are described.

**Chalcid Parasite of Mussel-scale.***—A. D. Imms has made an interesting study of *Aphelinus mytilaspidis* Le Baron, a Chalcid parasite of *Lepidosaphes ulmi* L., the commonest of the injurious Coccidæ found in Britain. The parasite passes through two generations in the year, and the adults consist almost entirely of females. Out of over 750 bred specimens, only ten were males. Parthenogenesis occurs, and is probably the usual method of reproduction. The adult insects seldom resort to flight, and have extremely limited powers of migration. They are positively phototropic, but exhibit no marked geotropic reaction.

In the first generation the adults appear in greatest frequency between the third week in June and the middle of July. The female lays a single egg on the dorsal or ventral surface of the body of the immature host, only the scaly covering of the latter being penetrated. The newly hatched larva closely resembles the full-grown stage in form, and during larval life the insect is an ectoparasite of its host. The second generation of adults mostly appears between the middle of August and the first week in September. They parasitize the sexually mature hosts, and the resulting larvæ hibernate through the winter, giving rise to the first generation of adults of the following year.

As the results of the first generation of parasites the affected hosts invariably die. In the case of the second generation of parasites the affected hosts usually deposit a small number of eggs before succumbing. The parasite exercises an inhibitory effect on oviposition, the essential reduction in the number of eggs not being primarily due, as stated by previous observers, to their destruction by the *Aphelinus* larvæ.

Assuming that every 1000 hosts lay on an average 37,200 eggs, the net results of a year's parasitism entails a reduction of about 7 p.c. of eggs laid. The efficiency of the parasite is therefore far below that of the most effective insecticides. This is primarily due to its very limited powers of migration, its relatively low fecundity, its marked susceptibility to unfavourable climatic conditions, and the fact that the effect of the second annual generation of parasites is only partial and incomplete.

**Ecology of Coccids.**†—G. Teodoro discusses the family of Coccidæ in their ecological aspects, referring particularly to peculiarities of structure and habit that come to have special practical importance. Such are the following: the chitinous cuticle, the production of wax and the like, the absence of wings on the females, the reduction of

* Quart. Journ. Micr. Sci., lxi. (1916) pp. 217–74 (2 pls. and 5 figs).
† Redia, xi. (1916) pp. 129–209 (3 pls. and 3 figs.).

stigmata, the small simple eyes of the female, the absence of a circulatory system, the presence and "transmission" of symbiotic micro-organisms, the occurrence of parthenogenesis, and the scarcity of males in many species.

**Parasite of White Rust Coccid.***—A. Berlese and G. Paoli describe a minute endophagous Chalcidid from Madeira, *Prospaltella lounsburyi* sp. n., which promises to be an effective parasite of the Coccid *Chrysomphalus dictyospermi*, which does serious damage (as *bianca-rossa*) to orange-trees. The antagonist attacks not only the adults but the nymphs, and large numbers were found parasitized.

**Rectal Gills of Larval Dragonflies.**†—R. J. Tillyard has studied the respiration of the larvæ of Anisopterid dragonflies, which is discharged by means of a secondarily closed tracheal system, though the spiracles of the thorax, at any rate, can, under certain circumstances, be made to function as orifices of inspiration if the larva leaves the water. In the Zygoptera there are caudal gills, in the Anisoptera rectal gills. In the Simplex system of rectal gills the rectal wall is thrown into six main longitudinal folds supported by cross folds: in the Duplex system the main folds are functionless or suppressed, and the cross folds become separate gills in six double rows. The gills are further classified, but whatever their type they are delicate eversions of the rectal wall into the rectal cavity.

Each gill includes eight elements: the cuticle, the epithelial syncytium, the pigment, the basal pad, the hypobranchial tissue, the blood plasma in the narrow blood spaces, the capillaries, and the larger tracheæ and efferents. These are discussed in turn. The pigment, the basal pad, the hypobranchial tissue, and the blood plasma are accessory to the essential process of respiration, and the larger tracheæ function only as receivers of oxygen from the capillaries. The essential problem is how the cuticle, the epithelial syncytium, and the tracheal capillaries combine to extract oxygen from the water in the rectal cavity.

According to one theory the gas simply diffuses through the delicate wall of the gill, as is suggested by the thinness and delicacy of the cuticle, the alteration of the undifferentiated rectal epithelium into a thin syncytium, the extreme fineness of the tracheal capillaries, and the complete absence of the spiral thread, the fact that the capillaries are embedded in the syncytium close to the surface, and that they all form complete loops, there being no circulation of gas in a definite direction, but simply a passage of gas from all points inwards towards the efferent tracheæ. The diffusion theory of Lowne and Ris is supported by the author's observations.

Tillyard considers (1) the method of filling the tracheæ with gas in the newly-hatched larvæ (the filling coming not from the rectum but from in front) which precedes the beginning of rectal respiration; (2) the process of diffusion during larval life; (3) the passage of oxygen along the tracheal tube; (4) the elimination of nitrogen; and

* Redia, xi. (1916) pp. 305–7 (2 figs.).
† Proc. Linnean Soc., New South Wales, xl. (1915) pp. 422–37 (1 pl.).

(5) the elimination of carbon dioxide. He concludes in favour of the diffusion theory. It is pointed out that the chitin which forms the cuticle of the gill and the intima (endotrachea) of the capillary tube, is a colloid substance which admits of the passage through it of gases by diffusion, and is particularly partial to carbonic acid gas. Attention is directed to the economical interplay implied in the use of the expulsion of water from the rectum as a means of propulsion and its use in supplying oxygen.

**Japanese Termites.***—Sanji Hozawa has described the Termites of Japan and given beautiful illustrations of the different forms of each species. It is interesting that Kämpfer should have given a circumstantial account of Japanese Termites more than two hundred years ago, while some naturalists and travellers of the nineteenth century have firmly denied the fact of their occurrence. The author finds that there are twelve to fourteen species, and deals with them in a very thorough way.

**Parthenogenesis in a Silk-moth.**†—A. Lécaillon finds that oviposition in females of *Bombyx mori* which have not been allowed to pair becomes very irregular. Some of the non-fertilized eggs exhibit the change of colour seen in fertilized eggs developing normally. Shaking the eggs did not increase the percentage of those that changed in colour. It is probable that those eggs which change colour are those which exhibit exceptional parthenogenesis.

**Orientation from a Distance in Ants.**‡—R. Brun continues his experiments on "homing" in ants. The "higher" ants, which are relatively long-sighted, are able to utilize large distant objects as landmarks: and some of the "lower" ants, which do not see distinctly except at short range, seem able to utilize big objects in some measure.

The higher ants can complete the hypothenuse of a triangle even from a considerable distance. This is due not to any kinæsthesia (or sense of angles), but to the utilization of a visible distant landmark.

In the same species there is some measure of local memory. The recognition of "known localities" is probably a function of the topochemical sense, while the choice of direction depends especially on visual memory (successive reiteration of differentiated visual landmarks).

Topochemical data of a more general kind have a certain rôle as secondary landmarks. Orientation after transport depends on the localization of illumination by the compound eyes, and is not exhibited if the illumination is bipolar.

Ants cannot associate a complex succession of diverse positions of the median plane of the body. Except within narrow limits there does not seem to be much kinæsthetic sense of attitudes. There is no "static sense." But ants are sensitive to gravity, and utilize the hints given by the slope of their route. There is no sense or memory of direction as

* Journ. Coll. Sci. Imp. Univ. Tokyo, xxxv. (1915) pp. 1–161 (4 pls. and 39 figs.).
† Comptes Rendus, clxii. (1916), pp. 234–6.
‡ Rev. Suisse Zool., xxiv. (1916) pp. 355–88.

such, for there is no power of orientation except under the influence of some of the various stimuli already referred to.

**Structure of Recurvaria nanella.***—A. Mignone gives a detailed account of the external features, appendages, and genital apparatus of this small moth.

### β. Myriopoda.

**Poison Glands and Salivary Glands of Centipedes.**†—J. W. Cornwall describes these in some Indian Scolopendrids, species of *Ethmostigmus*, *Rhysida* and *Otostigmus*. The orifice of the venom duct is oval and lies on the dorsal surface of the poison-claw, nearer the greater curvature and at a little distance from the apex. Besides the venom glands there are two pairs of salivary glands. There is also a third pair of glands in the fatty body laterally and somewhat dorsally to the salivary glands. Imbedded in the ventro-lateral fatty body there are what seem to be ductless hæmopoietic organs. Incidentally the author describes the reproductive organs.

The toxic action of the venom is relatively low and is of secondary importance. For the author is inclined to think that the main function of the poison glands is to secrete digestive ferments. Extract of the salivary and the third glands contains lysins, which are selective, besides anticoagulin, diastase, invertase and proteolytic enzymes.

### δ. Arachnida.

**Hydracarina from Strathearn.**‡—W. Williamson reports on a collection of Hydracarina which he made in the neighbourhood of Comrie. The most noteworthy capture was *Lebertia angulata* Sig Thor, not previously known to occur within the British area, and supposed to be restricted to Norway. The hitherto unknown nymph was found, and is carefully described.

**Colour of Huitfeldtia rectipes.**§—W. Williamson has a note on the colour of this Hydracarine, which was first recorded from Norway, then from Orkney, and now from the North of England. From information supplied by C. D. Soar the author states that the colour (hitherto undescribed, since the records were from preserved material) is an orange-brown with brown markings.

**Revision of Analgesinæ.**‖—E. L. Trouessart discusses the taxonomy of these plumicolous Sarcoptids. They differ from ordinary itch-mites in being restricted to birds, in not sucking the serum of the blood, in not causing itch, and in not having poisonous saliva. They feed on

* Rend. Accad. Lincei Roma, xxv. (1916) pp. 343–9, 423–8 (2 figs.).
† Indian Journ. Med. Research, iii. (1916) pp. 541–57 (5 pls.).
‡ Scottish Naturalist, 1916, pp. 89–91.
§ Scottish Naturalist, 1916, p. 92.
‖ Bull. Soc. Zool. France, xl. (1916) pp. 207–23.

epidermic products, and lodge between the barbs or get into the quills. They sometimes encyst in the subcutaneous connective tissue, and are occasionally found in the air-sacs. Trouessart defines four sections—Pterolicheæ, Analgeseæ, Proctophyllodeæ and Epidermopteæ—and makes notes on the genera composing each.

**Life-history of Anaphia petiolata.***—Marie V. Lebour calls attention to the present occurrence of larval Pycnogonids in the manubrium of Medusoids of *Obelia* sp., *Phialidium hemisphericum*, *Cosmetira pilosella*, and other forms. They were extremely abundant in June, after that became scarcer, and finally disappeared by October. They proved to be stages of *Anaphia petiolata* (= *Anoplodactylus petiolatus*), which Dogiel traced from its first entry into the *Obelia* hydroid to the older stages when it is ready to leave its host. What is now shown is that many of the larvæ manage in some way to enter a Medusoid. Possibly they cling to a Medusoid just as it is escaping from the colony, or perhaps they may get into a gonotheca before the liberation of the Medusoid. If Medusoids and Pycnogonids are left together in a vessel, the Pycnogonids are attracted to the Medusoids and cling to them.

### ε. Crustacea.

**Autotomy in Decapod Crustaceans.**†—J. Herbert Paul has continued his inquiry into the process of autotomy in Decapod Crustacea. He has studied the reflexes of autotomy in prawn, lobster, crayfish, hermit-crabs, Galatheids, shore-crab, edible crab, spider-crab, and swimmer-crab. It has been recorded by Przibram that if the leg of an Amphipod, e.g. *Gammarus*, be damaged or cut, the animal at once proceeds to bite the stump down to the level of the first segment. A similar behaviour is known in Tarantula. In Decapod Crustacea this autophagy does not exist as a normal reaction to injury, but it takes place under certain conditions.

The common prawn, when seized violently by a leg, extends the basal segment, and by a violent tail contraction tears the limb off at the free joint between the second and third segments. In the lobster and crayfish the same reaction takes place, but the rupture is at the level of a groove in the proximal part of the third segment. Previous to the tail contraction, moreover, a flexor muscle of the third segment weakens the limb at the level of the groove by pulling inwards one part of the ring of calcareous integument of the third segment central to the groove. There is a definite time relation between the various elements of the reflex, and autotomy can occur when the nerve-cord to the brain is cut. The reflex is plurisegmental, but the part of it that causes weakening of the limb at the breaking-plane is confined to one segment of the nervous system. If the limb be cut cleanly off and immediately freed, movements resembling autophagy in the lower forms result.

* Journ. Mar. Biol. Assoc., xi. (1916) pp. 51–6 (3 figs.).
† Proc. Roy. Soc. Edinburgh, xxxv. (1915) pp. 232–62 (29 figs.).

The limb may be cut off by the chelate walking-legs, and in the crayfish by the chelæ themselves.

In the hermit-crab the normal process of autotomy is the result of a unisegmental reflex, but if the animal be removed from its borrowed shell, plucking with the chelæ is necessary. The change of conditions has necessitated the reinforcement of the unisegmental reflex by arcs of higher levels, i.e. the reaction is plurisegmental. If the extensor muscle to the second segment be cut, the hermit-crab proceeds to bite the damaged limb down to the level of the breaking-plane in the second segment. Thus, with modification of conditions, three types of reaction to injury are exhibited—autotomy purely local, autotomy involving other levels of the nervous system, and autophagy.

In Galatheids autotomy can be performed by muscles at the base of the damaged limb alone. The reflex is unisegmental, but under changed conditions may be reinforced by arcs of other levels.

In crabs autotomy is almost always a purely unisegmental reflex. After injury, the extensors of the second segment, acting in opposite directions on the ring of hard integument central to the breaking-plane, cause weakening of the limb at this point, and division may take place at once, as may be the case in *Portunus*, or when the distal part of the limb meets an external point of resistance, usually the carapace. There is a definite time-relation between the contractions of the opposing extensors. In *Hyas*, when no external point of resistance can be found, the animal plucks off the damaged limb with its chelæ. This is the only case in which the unisegmental arc is reinforced from other levels.

Morphological complexity seen in the structure of the breaking-joint goes hand in hand with physiological specialization in the local or unisegmental arc. In Vertebrates the unisegmental reflex is regarded as primary; in Decapods the reaction is always unisegmental in the more highly specialized forms. Evasion and hæmostasis are the fundamental ends served by the self-amputation of limbs in Decapods. Autotomy is always the outcome of a nocuous stimulus applied to the leg which is abandoned

**Study of Fiddler-crabs.***—A. S. Pearse has made a study of *Uca pugnax* and *U. pugilator* at Woods Hole. They usually close their burrows when the tide comes in. On a hard bottom they pull a round piece of earth down over themselves; on a soft bottom they plaster up the opening somewhat, then enter the burrow, and, after pulling the mud down with the legs, push up material from below. Male fiddler-crabs try to induce the females to come to them by waving their chelipeds, and then try to make them enter the burrow. They use the great chela as a weapon for combat and defence and as a signal to attract the females. They do not use it as a stopper to their burrows, nor to dig, nor as a "nuptial couch" during copulation.

**Two Amphipods from Luzon.**†—C. F. Baker describes *Parorchestia luzonensis* sp. n. from the summit of Mount Maquiling, under stones

* Trans. Wisconsin Acad. Sci., xvii. (1914) pp. 791–802 (7 figs.).
† Philippine Journ. Sci., x. (1915) pp. 251–5 (3 pls.).

in the dripping mossy forest of the extinct crater, at an altitude of 1060 m., and *P. lagunæ* sp. n. from the great, shallow, freshwater lake of central Luzon, known as Bay Lake, and connected with the sea by Pasig River. The two species are closely related, and both are most nearly related to *P. sylvicola* (Dana) from the bottom of an extinct volcano in New Zealand. Search in streams between the two stations has so far failed to produce amphipods. The beach form has short antennæ and fully developed pleopods; the mountain form has long antennæ and reduced pleopods and heavier armature. Attention is drawn to the interesting fauna of Bay Lake, which includes the curious water-snake, *Chersydrus granulatus* Schneider, the blood of which is sometimes used by the fishermen to dye their nets.

**Habitat of Mesnilia martinensis.***—F. Mesnil and M. Caullery in their studies of the *Lithothamnion* littoral zone have noticed that the semi-parasitic Copepod *Mesnilia martinensis* Canu lives in the tubes of *Polydora flava*, an Annelid which makes a burrow between encrusting calcareous Algæ and the rock. The resemblance between *Mesnilia* and *Clausia* is emphasized. The two genera form a distinct group, allied to the Hersiliidæ.

**Antennules of Gynandromorph daphnias.**†—R. De. La Vaulx describes a number of anomalies in the antennules of the members of a culture of *D. atkinsoni*, with numerous gynandromorphs. It seems that gynandromorphism depends on unfavourable conditions in which there are few eggs at a time, and on some disturbance of the sex-cycle, perhaps some indecisive struggle between gamogenesis and parthenogenesis. A male antennule may be morphologically regarded as a female antennule much elongated, with the sensitive seta in an apical position and with a flagellum.

## Annulata.

**Development of Sperm Duct, Oviduct, and Spermatheca in Tubifex rivulorum.**‡—J. Bronté Gatenby finds that while the gonads appear very early in this worm, it is not till the animal is nearly half grown that the other parts of the genital organs begin to appear. The funnel of the sperm duct is the first part of the genital ducts to appear. The duct itself next begins to differentiate while the funnel is undergoing further development. While the sperm duct is still very incomplete the spermatheca begins to appear in segment ten. Last of all the oviduct is developed. The more highly differentiated structures begin to develop first. The development of the ducts is carefully described, the general results corroborating the modern view that the gonoducts are phylogenetically quite independent of nephridia.

* Bull. Soc. Zool. France, xl. (1915) pp. 176–8 (3 figs.).
† Bull. Soc. Zool. France, xl. (1916) pp. 194–7 (4 figs.).
‡ Quart. Journ. Micr. Sci., lxi. (1916) pp. 317–36 (1 pl. and 1 fig.).

**Remarkable Polychæt Parasite.***—M. Caullery and F. Mesnil have found a case of the unusual parasitism described by Saint-Joseph of *Labrorostratus parasiticus* S.J. (a Eunicid) inside *Odontosyllis ctenostoma* Clap. (a Syllid). The specimen was found on the *Lithothamnion* zone at Saint-Martin. The parasite extended along the greater part of its host's body, and seemed to be nearly adult, though without visible germ-cells. As Saint-Joseph has shown, the Eunicid passes out when adult and becomes sexual in free life. This is to be compared with what occurs in Monstrillidæ and entomophagous insects. The parasite does not differ much from free Eunicids. Five similar cases of parasitic Eunicids have been recorded: — ? *Lumbriconereis* sp. in *Marphysa sanguinea*, *Oligognathus bonelliæ* in *Bonellia viridis*, *Hæmatocleptes terebellidis* in *Terebellides strömi*, *Oligognathus parasiticus* in *Spio mecznikovianus*, and *Labidognathus parasiticus* in a Terebellid.

**Profuse Liberation of Spermatozoa in Lithothamnion Zone.**†—F. Mesnil and M. Caullery observed on the evening of August 18, 1915, a widespread milkiness in the pools of the *Lithothamnion* littoral zone. This was due to a profuse discharge of spermatozoa, and their attention was first of all directed to large mature specimens of *Audouinia tentaculata* Mont. Further investigation showed, however, that the spermatozoa which caused the milkiness were more like those of *Lysidice ninetta*, which also occurred in the locality. When ripe specimens of *Lysidice* are disturbed they often burst into pieces as they swim off, liberating the reproductive cells in a fashion somewhat like that of the Palolo worm. It is probable that the milkiness was due to *Lysidice*.

**New Species of Polycirrus.**‡—M. Caullery describes *Polycirrus* (*Leucariste*) *arenivorus* sp. n. from Saint-Martin, an interesting form that makes a U-shaped tube, like that of the lobworm, in very fine sand. It has very long whitish tentacles, a yellowish thorax, a colourless abdomen. It eats the sand and autotomizes readily below the tenth segment. It is frequently infected externally by a remarkable Copepod *Xenocœloma brumpti* Caull. et Mesnil.

**Development of Stratiodrilus.**§—W. A. Haswell has made a contribution—practically the first—to the embryology of the Histriobdellidæ. There is no metamorphosis. Segmentation is complete, but unequal, and resembles closely the corresponding process in the Rotifera. At an early stage in segmentation one of the cells ceases to take part in the process of division and becomes converted into a mass of non-nucleated finely granular material (secondary yolk), which remains distinct till a late stage. A large vegetal cell at one pole becomes immersed among the neighbouring cells, and the cells to which it gives rise in the interior of the embryo probably represent, in part at least,

* Bull. Soc. Zool. France, xl. (1915) pp. 160–1 (1 fig.).
† Bull. Soc. Zool. France., xl. (1915) pp. 198–200 (2 figs.).
‡ Bull. Soc. Zool. France, xl (1916) pp. 239–48.
§ Quart. Journ. Micr. Sci., lxi. (1916) pp. 301–12 (1 pl. and 4 figs.).

an endodermal layer. Complete coalescence subsequently takes place between all the cells of the embryo, this resulting in the formation of a syncytium in which the rudiments of organs first appear as a marshalling and multiplication of nuclei. The author inclines to adhere to his view that the Histriobdellidæ have some notable resemblances to Rotifera.

### Nematohelminthes.

**Anomaly in Buccal Apparatus of Ascaris megalocephala.***—Emile André describes a peculiar condition in one out of thirty-seven specimens taken from the intestine of a horse. The three lips were replaced by four soft, flat, muscular, appendages in the form of languets. They were 14–15 mm. in length, 2 mm. broad at the base, and tapering to a thread. A fine longitudinal striation was due to the muscle-fibres moulding the delicate cuticle. The worm could not have attacked the mucous membrane of its host either for nourishment or fixation.

**Genus Tanqua.**†—H. A. Baylis describes *Tanqua diadema* sp. n., from the intestine of the South American fresh-water snake, *Helicops angulatus*. The type-species, *T. tiara* (v. Linst.) occurs in monitors (*Varanus*) and some semi-aquatic snakes. A third species, *T. anomala* (v. Linst.), from the stomach of *Tropidonotus piscator*, was described by von Linstow as *Heterakis anomala*. The genus is one of the Gnathostomidæ. On each of the two lips there are three rounded tooth-like projections, and the teeth of one lip can interlock with those of the other. At the base of the head there are four rounded submedian cuticular swellings with transverse striations. The cuticle is thick, and may be loosened anteriorly, forming a protective sheath. There are four elongate cervical glands, opening to the exterior on the basal portion of the head. The tail of the male has eight pairs of elongate papillæ.

**Oxyuridæ.**‡—A. Railliet and A. Henry present a synopsis of this family of Nematodes. Their system is based primarily on the spicules, secondarily on the position of the vulva. Five sections are recognized: (1) with a single spicule and no accessory piece; (2) with a spicule and an accessory piece: (3) with two equal spicules; (4) with two equal spicules and an accessory piece; (5) with two unequal spicules and accessory piece.

**Nematodes and Other Worms from Falkland Islands.**§—H. A. Baylis reports on three Nemertines, seven Nematodes, and an Enchytræid collected by Mr. Rupert Vallentin in the Falkland Islands. The Nematodes include *Stenolaimus serialis* sp. n., the chief peculiarity of which is that instead of the pair of circular or spiral lateral organs near the anterior end in the majority of free-living Nematodes, there appears to be on either side a longitudinal row of thirty or more very small pits

* Rev. Suisse Zool., xxiv. (1916) pp. 351–3 (2 figs.).
† Ann. Mag. Nat. Hist., xvii. (1916) pp. 223–32 (4 figs.).
‡ C.R. Soc. Biol. Paris, lxxix. (1916) pp. 113–5.
§ Ann. Nat. Hist., xvii. (1916) pp. 288–98 (4 figs.).

in the cuticle which may possibly be regarded as "lateral organs." Another new species is *Dolicholaimus vallentini*, which agrees well in essential points with the type-species, *D. marionis* de Man.

**New Nematodes Parasitic on Insects.*** — J. H. Merrill and A. L. Ford, while investigating the life-history of the elm-borer *Saperda tridentata* and of the Termite *Leucotermes lucifugus*, found a new Nematode parasitic in each. These were submitted to N. A. Cobb, who has described and figured them in this paper, naming the parasite of the elm-borer *Diplogaster labiata* and that of the Termite *Diplogaster aerivora*. The former infests the intestine of the elm-borer in such large numbers that it interferes with its natural functions, rupturing the walls of the canal. It escapes into the general cavity of the insect, and thus causes its death. The length of the adult female is 0·66 mm. and of the male 0·72 mm. The other Nematode is parasitic in the head of the Termite, causing its death only when heavily infested. The adult female is 1·5 mm. in length and the male 0·8 mm. The eggs of *D. labiata*, the authors state, hatch in from thirty to thirty-two hours, and are deposited singly, while those of *D. aerivora* hatch in about eighteen hours and are deposited in groups. *D. labiata* is the longer in maturing and mating, usually mates but once, and its period of oviposition lasts about two days; while *D. aerivora* mates repeatedly, and its period of oviposition lasts about thirteen days. Plentiful food acts as a stimulant to reproduction. Both species moult. Figures of the two species, from the egg to the adult, occupy three pages.

## Platyhelminthes.

**Larval Trematodes in Medusoids.**† — Marie V. Lebour finds that Medusoids (*Obelia* sp., *Cosmetira pilosella*, *Turris pileata* and *Phialidium hemisphericum*) are at times abundantly infected with the larval stages of *Pharyngora bacillaris*, which Nicoll found free in tow-nettings. The adult is a common parasite of the mackerel. The larva was also found clinging to the inside of the stomach of the Ctenophore, *Pleurobrachia pileus*, but this was the only host other than a Medusoid on which it was observed. This points to genuine parasitism. In most cases the larva was found clinging to the manubrium or stomach wall, but sometimes it was simply under the umbrella. There seems to be no encysted stage. It is probable that a Mollusc serves as first host. The larval form observed is very like the adult.

**Life-history of Lecithodendrium chilostomum.**‡ — K. I. Skriabine has found that this Trematode, found in the intestine of the bats of central Europe, has for its intermediate host an insect, a species of *Phryganea*, and that it attains sexual maturity in the body of the intermediate host. It occurs inside a protective cyst. When the insect is devoured by the bat, the cyst is doubtless got rid of. The eggs will

* Journ. Agric. Research, vi. (1916) pp. 115–27 (3 figs.).
† Journ. Mar. Biol. Assoc., xi. (1916) pp. 57–9 (1 fig.).
‡ C.R. Soc. Biol. Paris, lxxviii. (1915) pp. 751–4.

pass out with the excrement of the bat and probably hatch in water, whence the larvæ may pass into the insect. In any case, the intermediate host has been discovered.

**Some Swiss Cercariæ.***—O. Fuhrmann describes a new kind of cercaria (*Cercaria letifera* sp. n.) with a forked tail which occurred in *Limnæa auricularia*. The cercariæ are formed within sporocysts, and when they are liberated they attack fishes with rapidly fatal results. Through skin and gills they enter the circulation, and by means of their anterior armature and ventral sucker cause hæmorrhage. They also block the capillaries. The final host is probably a fish or a fish-eating bird. Fuhrmann also describes a new cercaria (*Cercariæum squamosum* sp. n.) which has no trace of tail. Rediæ were found in *Limnæa auricularia*, var. *ampla*, and there were eighteen to thirty cercariæ in each. There is a characteristic investment of minute scales covering the whole body, except a median line between the buccal and the ventral sucker.

**Development of Emplectonema gracile Stimpson.**†—H. C. Delsman has studied the development of this Nemertean. The eggs are laid singly, each in a gelatinous envelope. The diameter is 135–140 $\mu$. The cleavage is of the spiral type, alternately to right and left. In contrast to what occurs in Annelids, Molluscs, and Polyclads, there is a strong development of the animal half. In the 8-cell stage the four cells of the first ectomere quartet are considerably larger than the four cells at the vegetative pole. The four quadrants are and remain alike. The larger cells divide more rapidly than the smaller (Kofoid's law). The smaller cells of the vegetative half lag behind those of the animal half. In consequence of this the difference in size between the two halves disappears, and a division of the fourth quartet does not take place before gastrulation, so that is cannot be determined whether *4d*, the mother-cell of the cœlomic mesoblasts in the types mentioned above, differs from *4a*, *4b*, *4c*. The radial symmetry is not disturbed before gastrulation, as it is in the other cases. It was not possible to observe the origin of the ectomesoderm. The gastrulation is at first like that in those Annelids and Molluscs that have eggs with little yolk. But the epithelial arrangement of the endoderm cells soon disappears. They form an irregular mass with which immigrant cells from the ectoderm are associated. Gastrocœl and blastocœl disappear. Flattened ectoderm cells form a thin ciliated larval envelope; the others sink in and form a compact undifferentiated mass, suggesting the pupæ of flies. Thus there is a well-marked metamorphosis.

## Cœlentera.

**Structure and Development of Sporosacs of Dicoryne.**‡—J. H. Ashworth and James Ritchie have studied colonies of *Dicoryne conybearei*

* Rev. Suisse Zool., xxiv. (1916) pp. 389–96 (1 pl.).
† Tijdschr. Nederland. Dierk. Ver., xiv. (1915) pp. 68–114 (4 pls. and 2 figs.).
‡ Trans. Roy. Soc. Edinburgh, li. (1915) pp. 257–85 ( 3 pls. and 3 figs.).

from Naples. The colonies grew on shells of Nassa. The hydrocaulus springs from a network of creeping hydrorhizal tubes, reaches a height of 4–8 mm., and is either simple or furnished with a few branches, which arise acutely from the stem and are seldom subdivided. A well-developed perisarc is present, slightly and irregularly wrinkled throughout its length. It is covered with a dense coat of foreign particles, and widens at the base of each polyp into a shallow cup-like expansion. Up to four to eight polyps are borne on a single hydrocaulus, and these are furnished, according to age, with six to sixteen tentacles in a single whorl.

Blastostyles arise on the stolon and on the hydrocaulus; their basal portion is covered with perisarc which terminates in a cup-like expansion similar to that beneath the polyps. Around the blastostyle the sporosacs, in general eighteen to twenty-four, and exceptionally as many as thirty-four to forty, are grouped in a spherical or elongate cluster. The sporosacs arise from a zone encircling the middle region of the blastostyle, the tip and base of which project beyond the mature cluster. In the adult state the sporosacs are free-swimming, are furnished with one tentacle, and are covered with cilia. Female sporosacs bear a solitary oocyte. The structure of the sporosacs is of the simplest nature, as they consist of a single layer of ectoderm between which and the endodermal spadix lies the oocyte or a mass of spermatozoa.

The authors discuss the medusoid- and polyp-homology of the sporosacs of *Dicoryne*. There is no evidence that they have undergone retrogression from the condition of medusoids or medusoid gonophores. It is also unsatisfactory to regard the sporosac as a modified hydranth. Indeed both comparisons are forced. The sporosac of *Dicoryne* is essentially an outgrowth of almost the simplest possible form, produced apparently by the stimulus due to the presence of the germ-cells. The ectoderm in which these lie grows *pari passu* with them and forms the envelope for them, the subjacent endoderm—which soon grows out as a "spadix"—is applied to the germ-cells and carries the supply of nutrient material necessary for their growth. This bud-like outgrowth, like other simple buds in the Hydrozoa, produces one or two tentacles, similar in structure to those of a polyp, and eventually becomes free. The most striking difference between such a bud and any other known in the Hydrozoa is its ciliation, which is probably a secondary adaptation. The free-swimming sporosacs of *Dicoryne* are the only ciliated reproductive members known in the Hydrozoa.

The fertilized eggs form blastulæ; the cleavage is total and unequal, or approximately so. Each blastomere shows a peripheral zone of granules different from yolk-spherules. The endoderm seems to be formed by multipolar immigration, and fills up the segmentation cavity. By the breaking down of the endoderm a cœlenteron is formed.

**Campanulina ceylonensis (Browne).***—R. E. Lloyd and Nelson Annandale describe this interesting Hydrozoon, whose medusoid was

* Records Indian Museum, xii. (1916) pp. 49–57 (3 pls. and 1 fig.).

described by Browne as *Irene ceylonensis*. The hydroid stage must be referred to the genus *Campanulina* van Beneden. Large numbers of medusoids, agreeing with Browne's figures and descriptions, appeared in a canal of brackish water in Calcutta, and young colonies of hydroids were reared in a bell-jar.

A characteristic feature of the hydranth is the webbing of the tentacles at the base: the tentacles are surrounded by regular circles of nematocysts: there is a short conical hypostome. The hydroid was found plentifully in association with the tube of a spioniform Polychæt. The gonosome usually grows from the base of a hydrosome and contains two medusoid buds. In its earliest phase the gonosome appears as a tubular outgrowth from the cœnosarc: this tubular outgrowth is a blastostyle; the medusæ arise from buds which spring from the stem of the blastostyle below the operculum. They appear to arise in the usual manner by the sinking in of an entocodon. Some account of the free medusoids is also given.

**Change of Symmetry in a Polyp.***—A. Drzewina and G. Bohn describe a living specimen of *Stauridium productum*, which showed in the arrangement of its tentacles a trimerous instead of a tetramerous symmetry. The tentacles developed in whorls of three, instead of in whorls of four. The authors call this phenomenon, not very happily, "symétrie metabolique," and regard it as probably an adjustment to the circumstances of the individual life.

## Porifera.

**New and Rare Hexætinellids.**†—Arthur Dendy reports on three Triaxonida, collected by H.M.S. 'Sealark' in the Indian Ocean. The first is *Autocalyx serialis*, a new species of a genus hitherto known only by fragments of the type species (*A. irregularis*), obtained by the 'Challenger.' The second is *Heterorete pulchra* g. et sp. n., related to Dactylocalyx, remarkable for the entire absence of special dermal and subdermal spicules, and, further, interesting in the presence of a commensal or parasitic hydroid ramifying through the substance of the wall, as well as of numerous Anthozoa attached to the surface. The third is *Sarostegia oculata*, a very beautiful and remarkable sponge, first described by Topsent from deep water off the Cape Verde Islands.

**Tetraxonids from Indian Ocean.**‡—Arthur Dendy deals with the Homosclerophora and Astrotetraxonida, collected by H.M.S. 'Sealark' in the Indian Ocean. The collection included twenty-five species, nine new. Hentschel's modification of Dendy's (1905) classification of Tetraxonids is followed, which recognizes three sub-orders: Homosclerophora Dendy, Astrotetraxonida Hentschel (= Astrophora + Astro-

* C.R. Soc. Biol. Paris, lxxix. (1916) pp. 131–4 (1 fig.).
† Trans. Linn. Soc. (Zool.) xvii. (1916) pp. 211–24 (4 pls.).
‡ Trans. Linn. Soc. (Zool.) xvii. (1916) pp. 225–71 (5 pls.).

monaxonellida Dendy), and Sigmatotetraxonida Hentschel (= Sigmatophora + Sigmatomonaxonellida Dendy. Thus the old artificial distinction between "Tetractinellids" and "Monaxonids" is got rid of.

## Protozoa.

**Reflexes in Protozoa.***—S. Metalnikov has studied the reactions of Infusorians to food, and has been impressed by their variability. Both in the movements which effect ingestion, and in the internal processes of vacuole-formation and circulation there is considerable diversity in the same animal. The variability depends (1) on the nature of the excitant, i.e. the composition of the food; (2) on the environmental conditions, e.g. of temperature; and (3) on the physiological condition of the Infusorians, which is affected by past experiences. The change in the reflex is sometimes definitely regulative, furthering the interests of the organism as a whole. Metalnikov refers to the distinction drawn by Beer, Bethe, and Uexküll between a uniform reflex and a variable "antiklise," by Loeb between constant and temporary reflexes, by Pavlov between unconditional and conditional reflexes.

Metalnikov holds that reflexes in Infusorians are far from being stereotyped. In regard to a digestive vacuole, for instance, it may vary in size, shape, course, stoppages, and duration. Every reaction has an original element. This is to be seen in all organisms. It may be verified in the varied beating of the heart. An organism enregisters its experience and is always changing. It is always doing something new, "creating," expressing its changeful individuality. The individual creation which we call variation is but a small part of the general creation which we call evolution. Metalnikov makes no reference to the author of "L'Evolution Créatrice."

**Foraminifera of West of Scotland.**†—Edward Heron-Allen and Arthur Earland report on a collection made in July–September, 1913, by W. A. Herdman on a cruise of S.Y. 'Runa' on the West of Scotland. Though they record only one (or two?) species, and a variety or two, new to science, no fewer than twenty-seven species are recorded for the first time for the British List. The total number of species and varieties identified in the gatherings is 324. The number would have been greater had there been a greater admixture of shells or stones, and if the dredgings had not been restricted to comparatively shallow waters, the greatest depth being 60 fathoms.

**Culture of Amœbæ.**‡—Charles A. Kofoid calls attention to the abundance of *Amœba proteus* among a felt of *Oscillaria* at the outlet of a drain or among decaying *Ceratophyllum*. He has cultivated with success for class purposes a small soil-amœba, *Nægleria gruberi*, which, though very small, not very mobile at room temperatures, lacking in prominent pseudopodia, and apt to enflagellate on slight provocation, has

* C.R. Soc. Biol. Paris, lxxix. (1916) pp. 80–82.
† Trans. Linn. Soc. (Zool.) xi. (1916) pp. 197–299 (5 pls. and map).
‡ Trans. Amer. Micr. Soc., xxxiv. (1915) pp. 271–4.

the compensating advantages of the large numbers easily obtained, the occurrence of encysted, amœboid, and flagellate forms, and of both exogenous and endogenous budding, and the ease and certainty of securing cultures and making slides of the various stages. The nutrient fluid used was a mixture of 50 grm. each of lettuce-leaves, horse-manure, soda cracker, and garden soil, boiled for half-an-hour in 1 litre of tap-water. The fluid is sterilized for half-an-hour, and when thoroughly cool is shaken up with a little soil. On floating cover-glasses the amœbæ adhere in astounding numbers. The conditions which stimulate en-flagellation are apparently access of oxygen and new food supply.

**New Species of Licnophora.***—A. P. Dustin describes *Licnophora bullæ* sp. n., which he found in *Bulla hydralis* near Roscoff. Like other representatives of the genus, whose species have been reported from Nudibranchs, Echinoderms, and other types, *L. bullæ* is a large Ciliate, divided into a disk of attachment, a narrow neck, and the body proper. The ventral surface of the body proper is flattened or slightly hollowed out, the dorsal surface is convex. At the lower end of the ventral surface there is an oval cytostome, surrounded by a crown of numerous powerful cilia. The attaching disk is rounded or cordate, hollowed out like a cup, and surrounded in typical forms with four whorls of cilia, and outside these a fine circular membrane or velum. The disk is sometimes simplified by the absence of the velum and one or more of the ciliated wreaths. The neck seems to be contractile, and bears on one side a delicate membranella. The body contains Diatoms and other Algæ, on which the animal feeds. The micronucleus is small and spherical. The macronucleus consists of a large moniliform chain, or more frequently of numerous distinct pieces. There is an exceedingly well-developed system of intracellular fibrils, similar to that described by Miss Stevens in another form from a Holothurian. It may be skeletal, but it is probably contractile and elastic.

**Inheritance of Abnormalities in Paramecium.**†—R. J. Stocking publishes the results of an experimental study of the inheritance of abnormalities in *Paramecium* after conjugation. The principal points studied were: The origin and nature of abnormalities; their relation to conjugation; their inheritance and variation in uniparental reproduction; how precisely inheritance occurs; whether there are variations of kind and degree of abnormality, and whether these variations are inherited; whether abnormal stocks multiplying asexually can be modified in their hereditary characteristics; and the relation of abnormalities to bi-parental inheritance, and to survival. A large proportion (from 36 to 81 p.c.) of the progeny of exconjugants of *P. caudatum* show abnormalities frequently and constantly. Some lines show no abnormalities, others a small proportion of abnormal individuals, and in a few abnormality is universal. The tendency to abnormality is transmitted in fission: in one case there was inheritance of a specific type carried through two or three generations. In a very large pro-

* Bull. Soc. Zool. France, xl. (1915) pp. 179–84 (3 figs.).
† Journ. Exper. Zool. xix. (1915) pp. 387–450 (20 figs.).

portion of the races in which abnormals were regularly discarded and only normals retained to carry on the race, the abnormal character persistently reappeared. Single lines, derived by fission from a single parent, were divided, by selection, into two or more races differing hereditarily. This was successfully accomplished in twenty-five races: from each of these were isolated two sorts of lines, one quite normal, the other continually producing abnormalities. Selection was effective even when begun with the progeny of a single individual that had appeared many generations after conjugation. In a race of *Paramecium* which shows no hereditary abnormalities, conjugation results in the appearance of many lines which are hereditarily abnormal, and others which are normal throughout (Jennings' "production of variation by conjugation"). In the diverse lines descended from the different exconjugants of a conjugating culture, the two lines descended from the two individuals that have conjugated together tend to be alike in respect of normality or abnormality—that is, the characteristics of the progeny of A are not determined by the nature of A alone, but partly also by the fact that A has conjugated with B.

The paper concludes with a comparison of the genetics of these "abnormalities" in *Paramecium* with those in other organisms.

**Mitochondria of Balantidium.***—L. Léger and O. Duboscq describe in *B. elongatum* the presence of numerous bacilliform mitochondria, genuine chondrioconts, in the cortical plasma, below the alveolar layer of the ectoplasm. The minute rods are about 3 $\mu$ in length, straight or curved, and divide into two or three segments. In the peristomial region they are very numerous and lie at right angles to the surface. In the median region there are fewer, and most are parallel to the surface. Posteriorly they become more numerous and lie at right angles to the margin. Similar rods were described by Zoja in 1891 in what seems to have been *B. entozoon*. The endoplasm shows few chondrioconts, but there is fibrillar differentiation and there are corpuscles of paraglycogen and siderophilous spheroplasts.

**Bud-formation in Dendrocometes paradoxus.**†—Geoffrey Lapage and J. T. Wadsworth have studied the internal budding of this interesting Acinetarian which is epizoic on the gills of *Gammarus pulex*. Each individual produces a single bud at each reproductive act. The bud is roughly oval and plano-convex in shape, measuring 0·06 × 0·04 mm. The convex surface is dorsal and is devoid of cilia. The opposite ventral surface bears numerous long cilia, inserted along four ciliated ridges. This surface, hitherto regarded as flat, is in reality convex in the outer ciliated area, concave in the centre. The bud has, like the parent, three micronuclei.

Bud-formation begins by a linear dissolution of the parent, which proceeds until a dome-shaped mass of cytoplasm is marked off. This

* C.R. Soc. Biol. Paris, lxxix. (1916) pp. 46–8 (3 figs.).
† Quart. Journ. Micr. Sci., lxi. (1916) pp. 337–82 (2 pls. and 16 figs.).

mass is subsequently organized into the bud, acquiring a contractile vacuole and four ciliated ridges.

The area over which the dissolution takes place constitutes the so-called "brood-chamber," but it is not a definite space, and there is no definite opening to the exterior, except at the moment of birth. The orientation, development, and birth of the bud are described.

Division of the meganucleus of the parent is amitotic. The meganucleus does not possess a true achromatinic nuclear membrane, but the surface layer of chromatin is so arranged as to form a false chromatinic membrane. Division of the meganucleus is always complete before the bud leaves the body of the parent. Division of the micronuclei, on the other hand, is by a primitive kind of mitosis. No chromosomes or visible kinetic centres are present.

Reference is also made to the migration of the adult from one gill to another, a moribund residuum being left behind. This process may simulate bud-formation, and is either of the nature of an excretory process (as Bütschli suggested) or associated with ecdysis in the host. Attention is called to an area of special cytoplasm which is found in the bud during its formation, but the significance of the structure remains obscure.

**Modification of Spirochætes.***—Hideyo Noguchi discusses certain alterations in the biological properties of Spirochætes induced by artificial cultivation. He has succeeded in obtaining in pure cultures the following varieties of the *Treponema* group:—*T. pallidum*, *T. pertenue*, *T. macrodentium*, *T. microdentium*, *T. mucosum*, *T. calligyrum*, and *T. refringens*. These retain their structural characters for two to four years, but they may change in vital properties. In the case of *T. pallidum* the virulence disappeared within about four months after its purification; a strain of *T. pertenue* lost its virulence as soon as it was isolated; the strong odour of *T. microdentium* gradually disappeared after a year; the mucin-producing property of *T. mucosum* disappeared in about five months. The new environments seem to bring about the disuse and functional loss of certain properties.

**Gregarines of Glycera.**†—Helen L. M. Pixell-Goodrich discusses the numerous gregarines which occur in the large Polychæt, *Glycera siphonostoma*. There appear to be four different forms, including, at least, one species of *Gonospora* (*G. glyceræ* sp. n), which is described. It is surrounded for the greater part of its existence by a layer of host-epithelium. Association is made secure by means of a dovetail arrangement. The spores, under high magnification, reveal a more complicated structure than has previously been described in the genus.

**New Parasite from a Tick.**‡—Éd. Chatton and G. Blanc describe a new parasite from *Rhipicephalus sanguineus* (a tick of the dog, rabbit, etc., found in this case on the gundi, *Ctenodactylus gundi*,

* Ann. Inst. Pasteur, xxx. (1916) pp. 1–4.
† Quart. Journ. Micr. Sci., lxi. (1916) pp. 205–16 (1 pl.).
‡ C.R. Soc. Biol. Paris, lxxix. (1916) pp. 134–8 (2 figs.).

a North African rodent). The new form—*Cryptoplasma rhipicephali* g. et sp. n.—is a cytoplasmic mass, without evident nuclear system, enclosed in a thick shell, outside which there is a helicoid body which stains like a nucleus, but is not accompanied by any cytoplasm. It may be that the "parasite" represents a combination of two elements—the outer, a host-cell, e.g. a blood corpuscle, reduced to its nucleus; and an inner, the Protist proper. But the case requires further investigation.

**Blood Parasite of Tarantula.*** — Éd. Chatton and G. Blanc discuss *Pirhemocyton tarentolæ*, which they reported in 1914 from the blood corpuscles of *Tarentola mauritanica*. There are young spherical homogeneous forms with diffuse chromatin, amœboid forms with condensed chromatin masses of varied shape, large spherical forms with peripheral chromatin particles and a central corpuscle. The interpretation of these three forms must be deferred until more is known. No multiplication of the parasite (or parasites?) was observed in the blood corpuscles or elsewhere.

**Parasitic Protozoa in Spain.**†—Fidel Fernandez Martinez takes a survey of the parasitic Protozoa observed in Granada, Malaya and Almeria, and deals in particular with *Leishmania infantum* and *Entamœba histolytica*.

* C.R. Soc. Biol. Paris, lxxix. (1916) pp. 39–43 (1 fig.).
† Mem. R. Soc. Espãn Hist. Nat., x. (1916) pp. 193–265 (11 figs.).

# BOTANY.

## GENERAL,

### Including the Anatomy and Physiology of Seed Plants.

#### Cytology,

##### Including Cell-contents.

**The Chondriome in Fungi and Algæ.***—A. Guillermond has made a long study of this body, which he considers of equal importance with the nucleus in the life of the cell. He sums up his work thus:—1. The presence of the chondriome has been demonstrated in so many diverse forms that it appears to be universal. 2. In Algæ it was impossible to prove its presence in the Conjugatæ or in the Confervaceæ, but it seems to be replaced by the chloroplast, which acts as a kind of "reticulum mitochondrial." Other workers have found the chondriome in the Florideæ and Phæophyceæ. 3. There is evidently no chondriome in the Cyanophyceæ. 4. As to the physiological function, they act in fungi as do the leucoplasts in the higher plants, forming reserve products as these latter form starch. Guillermond finds that the metachromatic corpuscles take origin in the cytoplasm near the nucleus and then migrate into the vacuoles.

#### Structure and Development.

##### Vegetative.

**Coniferous Wood of Potomac Formation.**†—E. W. Sinnott and H. H. Bartlett have studied numerous specimens of lignite and charcoal from the Potomac formations and find that these represent two types of conifers. The first type has wide tracheids with opposite pits, "bars of Sanio," and a few large tracheids near the rays. The specimens appear to be identical with *Cupressinoxylon McGeei*, but must now be regarded as *Podocarpoxylon McGeei*, probably a species of *Nageiopsis* having close affinities with the Podocarpineæ.

The second type has narrow tracheids with small pits, no "bars of Sanio," and a few pits near the rays; wood-parenchyma is present, the rays are shallow and thin-walled, and there are well-developed resin-canals. This type is classified as *Paracupressinoxylon potomacense*, probably a species of *Arthrotaxopsis*, belonging to a group of small-leaved mesozoic conifers having Araucarian affinities.

* Rev. Gén. Bot., xxvii. (1915) pp. 193–207, 236–53, 271–88, 297–315 (12 pls.).
† Amer. Journ. Sci., xli. (1916) pp. 276–93 (18 figs.).

**Cuticles of some Indian Fossil Conifers.***—Ruth Holden gives the following results of her study of several species. A comparative study of living and fossil conifers indicates that epidermal structures are of great value for accurate diagnoses, but of relatively little importance for indicating affinities. On account of the character of its cuticle, the so-called *Palissya indica* of Feistmantel cannot properly be referred to that or any other fossil genus; and to point out its resemblance to the living *Retinospora*, it is suggested that it may be called *Retinosporitis indica*. *Echinostrobus expansus* closely resembles many living members of the Cupressineæ, both in epidermis and in phyllotaxy; accordingly it would seem better to retain the old name of Lindley and Hutton, *Thuyitis expansus*. *Taxitis tenerrimus* has a type of cuticle common to many extant conifers, and its affinities cannot be decided. The epidermal structure of *Podozamites lanceolatus* constitutes another reason for referring that genus to the conifers rather than to the cycads.

**Comparative Anatomy of Box Elder (Negundo).**†—As a result of the studies and observations outlined in this paper, A. B. Plowman is of the opinion that the box elder, in its present highly specialized form, is a product of the Glacial Period. The evidence may be stated concisely as follows. *Negundo* characters were but slightly developed before the Pleistocene or Glacial Period. They have been widespread since that time. *Negundo* occurs in greatest abundance in regions of the richest glacial drift, especially upon and below the great terminal moraines. *Negundo* characters were apparently developed rapidly, and partially fixed, through exposure to the inclement conditions along the margins of the great continental ice sheet. It was apparently a primitive variant from the ancestral *Acer* stock, possessing peculiarities especially adapted to glacial conditions. These features were greatly emphasized by the glacial experience of the species. The impetus gained from glacial influences is not yet lost; *Negundo* is highly variable, yet irretrievably separated from the true maples. The nearest points of correspondence are found in *Acer pennsylvanica*, *A. spicatum*, and *A. platinoides*.

Characters of *Negundo* that would fit it for glacial environment are as follows: (*a*) leaf morphology and anatomy, indicating maximum utilization of light; (*b*) medullary strands in petiole, indicating great capacity for transportation; (*c*) extended insertion of leaf-trace into stele; (*d*) colour of twigs, indicating energy absorption and protection; (*e*) intermediate growth, indicating a maximum growing season; (*f*) food storage capacity, indicated by the amyliferous tissue; (*g*) high vitality of lateral buds; and (*h*) vegetative activity of shoots, ensuring quick response to warmth and light; (*i*) medullary rays, marginal cells, extension into bark; (*j*) large and numerous pits in wood elements; (*k*) bark: thick, tough, elastic, persistent; (*l*) unobstructed conduction in roots; (*m*) great extent of root system; (*n*) large number of seeds; (*o*) anemophily; (*p*) extreme protection of embryo; thick,

* Bot. Gaz., lx. (1915) pp. 215–27 (1 pl.).
† Bot. Gaz., lx. (1915) pp. 169–92 (6 pls.).

resistant seed-coats: (*q*) food storage in embryo; and (*r*) fruit long persistent on the tree.

**Anatomy of Leaves of Bromeliaceæ.***—E. Keiline has studied the leaves of numerous species belonging to the Bromeliaceæ in order to discover the relation between the anatomy and the mode of life of the plant, and finds that there are three different types of structure.

The first type is characteristic of plants which are wholly adapted to a terrestrial habitat; the leaves have well-developed vascular bundles in which the xylem is especially prominent; the fibres surrounding the bundles are non-sclerenchymatous, and epidermal scales are rare except where needed for the protection of stomata.

The second type is characteristic of a genus in which most of the species are epiphytic, but are capable of a terrestrial mode of life. In this case the vascular bundles are relatively less well-developed; the fibres surrounding the bundles are sclerenchymatous; epidermal scales are of frequent occurrence and serve the purpose of absorption; fibres also occur in the aqueous or chlorophyll tissue.

The third type is characteristic of complete epiphytes. The leaves of these plants have poorly developed vascular bundles; the fibres surrounding the bundles are numerous and well-developed; epidermal scales are very numerous, covering the entire surface and playing an important part in the work of absorption; the epidermis itself is more or less impregnated with sclerenchyma.

In the case of *Æchmea fulgens* it was shown by experiment that the epidermal scales are present or fail to develop in response to the conditions of habitat.

**Chemical and Histological Characters of Radish.**†—M. Molliard publishes a second paper dealing with the modifications of structure and of reserve-materials resulting from placing the roots of plants in concentrated solutions of sugar. The first series of experiments made with the radish showed that concentrated solutions of such sugars as glucose and saccharose caused considerable alterations in the nature and concentration of sugars stored in the tissues, and that the tissues themselves underwent considerable modification. The present work shows that these conditions are accompanied by corresponding changes in nitrogenous reserves and also by certain distinct anatomical changes in the tubercles. Similar plants were grown: (1) in ordinary soil in the open air; (2) similarly in pots in a greenhouse; (3) in 5 p.c. solution of glucose; (4) in 10 p.c. solution of glucose; (5) in 10 p.c. solution of saccharose; and (6) in 15 p.c. solution of saccharose. The reserve-materials showed little difference in the first two cases, but the last four experiments showed a marked increase in the total sugar-reserve, more especially in the non-reducing sugars; the amount of starch was also increased, but in a smaller proportion. The solutions of saccharose produced more marked results than those of glucose.

* Rev. Gén. Bot., xxvii. (1915) pp. 77–95 (4 figs.).
† Rev. Gén. Bot., xxvii. (1915) pp. 161–8 (2 pls. and 2 figs.).

Similar results were obtained in the nitrogenous reserves—i.e. the greater the amount of sugar-solution absorbed the greater the nitrogenous reserve—but the results were less well-defined and were not in any definite proportion. The anatomy of tubercles grown under these conditions varies considerably from that seen under normal conditions. The normal tubercles show a clear distinction into two zones—a secondary parenchyma traversed by numerous vessels, and a narrower zone occupied by the cambial layer and the external fibro-vascular bundles. This distinction disappears in the tubercles grown in the sugar-solutions; not only are the bundles more regularly distributed, but the constituent parts are also modified. In some cases the vessels assume a special form, having a lignified membrane with very accentuated pits, while in others they are reduced to simple parenchymatous stands with a thin cellulose membrane, capable of functioning as reserve-tissues. This modification in structure appears to be directly due to the amount of sugar absorbed in the neighbourhood of any particular cell or vessel.

## CRYPTOGAMS.

### Pteridophyta.

(By A. Gepp, M.A., F.L.S.)

**Pteridospermeæ.***—L. Grandori describes a mesozoic pteridosperm-seed—*Liaspermum dissectum*, and discusses its affinity with palæozoic and living forms. It is very near to *Lomatopteris jurensis* (Kurr) Sch. And reasons are given for regarding *Macrozamia Moorei* as a species with primitive characters, which ally it to Bennettitales on the one hand, and to Pteridospermeæ on the other. A morphological study of it is being prepared by C. G. Chamberlain.

The same author † discusses the affinities of the fossil Pteropsida under the following heads:—1. The fossil ferns, isosporous and heterosporous. 2. The Pteridospermeæ—various types of stem, frond, reproductive organs. 3. Other Pteridospermeæ. 4. The affininity among the various forms of Pteridospermeæ, and their affinity with the ferns, Cycadales, Cordaitales, Bennettitales respectively. 5. Conclusions.

**Morphology of Phylloglossum.‡**—K. Sampson has reinvestigated the morphology of *Phylloglossum Drummondii*, and finds that the annual tuber is, in fertile plants, a modified branch—a conclusion which is supported by the following facts: 1. A gap is left in the stele of the main axis by the exit of the vascular strand of the tuber.

* Atti d. Accad. Sci. Veneto-Trentino-Istriana, viii. (Padova, 1916) pp. 107–16 (1 pl. and figs.).

† Atti d. Accad. Sci. Veneto-Trentino-Istriana, viii. (Padova, 1916) pp. 163–95 (figs.).

‡ Ann. Bot., xxx. (1916) pp. 315–31 (5 figs.).

2. The stele of the tuber often shows a corresponding gap. 3. The tuber bears leaves, some of which are considerably reduced. As to sterile plants, they generally consist of a simple axis, the apex of which has formed a storage tuber. It is possible that, in the larger specimens, branching occurs as in fertile plants, but the arm, which in the latter produces a cone, is in sterile plants arrested early in development. No longer can the tuber of *Phylloglossum* be compared with the protocorm of *Lycopodium cernuum*, but the two genera are brought nearer together, since *Phylloglossum* has proved to be not characteristically an unbranched form.

**Trichomanes Asnykii.***—A. Wodziezko has made a study of the morphology and anatomy of *Trichomanes Asnykii* Raciborski. He finds that the number of tracheids in the leaf-bundle increases greatly (up to more than ten) before the opening into the base of the indusium. The number of the bast-fibres is not increased, and since it is situated on one side (the lower side of the leaf) the bundle becomes collateral. Thus the tracheid lumen attains a considerable size. Besides the usual scalariform tracheids, there are also present reticulate tracheids. A little higher the vascular bundle divides into three equally stout portions, of which the middle one penetrates the receptacle, and the two lateral bundles pass into the indusium-wall. Each of the latter consists of three to five very small tracheids and two to three bast-fibres, collaterally distributed; they possess no cambiform elements inside the endodermis. The inside of the receptacle is traversed by a strongly developed bundle, consisting of five to six scalariform and reticulate tracheids. No other elements are present. In consequence of the stout formation of the vascular system, the receptacle constitutes a highly developed organ, concerning the function of which one can at present say nothing. No stomata or hydatodes were observed on the receptacle. The nearest allies of *T. Asnykii* are found in the sub-genus *Microtrichomanes* of Mettenius, in which the branching of the frond varies between dichotomous and pinnate. The species *T. digitatum*, *T. dichotomum*, *T. nitidulum*, etc.) were placed by Prantl in the genus *Gonocormus*. Among them are species in which pseudonerves are wanting, but which have dichotomous or pinnate branching of the frond. *T. Asnykii* is the most reduced type of *Gonocormus* (according to Prantl the most simple).

**Anatomy of Nephrolepis Tubers.**†—B. Sahni describes the vascular anatomy of the tubers of *Nephrolepis*. The strand of the branch-stolon penetrates the base of the tuber as a solid protostele and at once expands like a funnel, acquiring successively internal phloem, pericycle, endodermis and ground-tissue. Then the funnel-like stele breaks up and expands into a hollow net-work of tangentially flattened ribbon-like strands (each of concentric structure), enclosing gaps of irregular shape and size. These strands convex again into a single protostelic

* Bull. Accad. Sci. Cracovie (1915) pp. 202-11 (figs.). See also Bot. Centralbl., cxxxi. (1916) p. 453.

† New Phytologist, xv. (1916) pp. 72-80 (3 figs.).

strand, which ends, as a rule, in the apical mamelon, or is continued on into the stolon, if there be one. From this reticulate stele root-strands arise without order. The fusion of strands at the apex is similar to the disintegration of strands at the base. It is comparable to the transition from the protostelic to the dictyostelic condition in some fern-rhizomes. The gaps are not due to the influence of leaf-traces, for there are no leaves at all on the tuber. The dilatation of the solid stele into a hollow network may possibly be due to the necessity of supplying adequate food to all parts of the tuber. The reticulate stele is unique because all the gaps in it are what have technically been called "perforations."

## Bryophyta.

(By A. Gepp.)

**Development of Certain Bryophyta.***—E. Lampa finds that similar phenomena occur in certain stages of development in mosses. In a few-celled protonema of *Sphagnum* there arises an apical cell, as in a developing fern prothallium. This forms several segments, and then the whole structure increases greatly in size by means of marginal meristem. The *Sphagnum* plant proper is developed from a marginal cell of the thalloid protonema. This marginal cell is divided into two by a wall. From one of these cells an apical cell is cut off, and the further growth of the resulting plantlet is exactly the same as that of a young liverwort, to which it bears a remarkable resemblance. The plantlets grow very slowly; possibly for that reason the flat protonemata are necessary in order to increase the chances of life of the extremely tender buds. The papilla-like character of the younger leaves is noteworthy.

The filamentous protonemata of *Haplomitrium Hookeri* are not to be distinguished from those of a moss. The branching of the filament is very pronounced. The early foliage much recalls that of many Jungermanniaceæ. The shoot-rudiment of *Riccardia pinguis* is very like that of a moss. Researches on symbiosis with *Mycorrhiza* would be interesting. *Diphyscium foliosum* develops peculiar club-shaped growths, which, however, appear to have no connexion with the true moss plantlet. On that point further study is needed.

**Treubia insignis.**†—D. H. Campbell describes the archegonium and sporophyte of *Treubia insignis*, from material collected at the original locality, Tjibodas, in Java. The archegonium differs from that of other liverworts in having as many as nine rows of neck-cells; and there is no clear line of demarcation between neck and venter. The neck canal cells did not exceed eight, though Grün has found sixteen in the mature

* Oesterr. Bot. Zeitschr. lxv. (1915) pp. 195–204. See also Bot. Centralbl., cxxxi. (1916) p. 409.

† Proc. Nat. Acad. Sci. U.S.A. Washington, ii. (1916) pp. 30–1.

archegonium. The earliest stages of the embryo were not seen; but in the youngest example a large haustorium of large cells (as in *Pallavicinia*) was present, derived presumably from the lower half of the embryo. The rest of the embryo becomes differentiated into foot, seta and capsule, but the foot is not clearly delimited from the seta. In the capsule the sporogenous tissue is differentiated at a rather late stage. The capsular wall is three-layered, and the apex is thickened and conspicuously beaked, as in *Podomitrium* and *Pallavicinia*. The elaters are few, but long. In the absence of a perianth, the calyptra is very massive. The mature capsule is ovoid, and dehisces by four broad, rather irregular valves. Of all the Anacrogynæ, *Treubia* comes nearest to the acrogynous Jungermanniales. On the other side *Treubia* is nearest related to *Noteroclada*, which leads on to *Petalophyllum*, and so to *Fossombronia*, which shows some significant resemblances to the lowly Sphærocarpales.

**Metzgeria from Galapagos Islands.***—A. W. Evans describes and figures a new species of *Metzgeria* from the Galapagos Islands, *M. grandiflora*, collected by A. Stewart with nearly a score of other hepaticæ. The female inflorescence is unusually large, with remarkable connivent involucral wings. The thallus is strongly convolute, with marginal hairs only, and the cortical cells of the costa in two rows, both dorsally and ventrally. The author shows how the plant is distinguished from *M. comata*, *M. glaberrima*, and *M. sinuata*, its nearest allies.

**Hepaticæ of Europe.**†—K. Müller has advanced the publication of his "Die Lebermoose Deutschlands, Oesterreichs und der Schweiz" by the issue of five more parts, which treat of the Ptilidioideæ, Scapanioideæ, Pleurozioideæ, Raduloideæ, Madothecoideæ, Jubuleæ, and Lejeuneæ (beginning). The genus *Scapania* is divided into seven natural groups, named after the typical species of each, and two new species are described. The genus *Madotheca* is critically revised, and Nees's mistakes are put right. And some of the more recent species of *Frullania* and *Madotheca* are found to be identical with older North American species. *Lejeunea* is divided into several sub-genera.

**Dicranaceæ.**‡—I. Hagen, continuing his studies of the Norwegian moss-flora, treats of the family Dicranaceæ, sub-divided into Dicranoweisioideæ (with entire teeth), Trematodontoideæ (capsules with long stomatiferous neck), Campylopodoideæ (leaves very broad-nerved; perichætium distinct), Anisothecioideæ (leaves narrowly nerved; perichætium none), Dicranoideæ (alar cells more or less distinct; perichætium vaginant). In Dicranoweisioideæ he creates the new genus *Cnestrum* for *Rhabdoweisia schisti*; and transfers to this sub-family *Amphidium* on

* Torreya, xvi. (1916) pp. 67–70 (figs.).

† Rabenhorst's Krypt.-Flora, vi. Lief. 20–4 (Leipzig: Kummer, 1914–15) pp. 337–656 (figs. 99–183). See also Bot. Centralbl. cxxxi. (1916) pp. 409–11.

‡ K. Norske Videnskab. Selskab. Skrift., 1914 (Trondhjem, 1915) pp. 1–192.

the ground that its stem-structure is not of the type of the Orthotrichaceæ, among which *Amphidium* is usually placed. In Anisotheciоideae he employs the generic name *Pseudephemerum* (Lindb.) for *Pleuridium axillare*. In Dicranoideæ he creates the new genus *Gongronia* for *Cynodontium strumiferum*, *Kiæria* for the *falcatum* group of *Dicranum*, and *Scytalina* for *Dicranum montanum* and *D. flagellare*. In treating of the species he gives his reasons for converting several of them into varieties of other species; and he describes some nine new varieties.

**British Bryophyta.***—W. Ingham publishes the twenty-first annual report of the Moss Exchange Club, in which P. G. M. Rhodes states that a larger number of critical and atypical specimens have been gathered by the members during the past year. The critical notes published in the report are accordingly the more valuable for this reason, and treat of both mosses and hepatics.

**Rare Mosses from the Iberian Peninsula.†**—A. Luisier publishes a series of chapters on new and rare mosses gathered in Spain and Portugal:—1. *Triquetrella* is a genus hitherto found only in Australia, South Africa and Patagonia; but *T. arapilensis*, a new species with remarkable papillæ, described and figured by the author, extends the distribution of the genus to S.W. Europe. 2. *Bruchia vogesiaca* Schw. and *Didymodon Ehrenbergii* Kindb. (*Trichostomum* Lorentz) are very rare species from the Vosges and Sinai respectively, and have been detected by the author in the Iberian peninsula. 3. The North American genus and species *Claopodium Whippleanum* (Sull.) Ren. and Card. is represented in Portugal by *Leskea algarvica* Schimp., a synonym, and in Spain by a cavern-variety. 4. *Desmatodon meridionalis*, a new species from the south of Portugal, is described and figured. 5. *Brachymenium lusitanicum*, a new species described and figured by Hagen, adds to Europe a genus hitherto known only from tropical and sub-tropical regions. 6. The author adds nine species to Casares Gil's recent list of Iberian mosses.

**Japanese Bryophyta.‡**—S. Okamura publishes an illustrated contribution to the bryological flora of Japan, including descriptions and detailed figures of a new hepatic, and twenty new species and five varieties of mosses. He also describes *Meteoriella*, a new genus founded on *Meteorium solutum*. He also gives some excellent figures of a few previously known mosses; for example, *Schistostega osmundacea* Mohr. The plants enumerated come from Sachalin, Linchu Islands, and Corea.

* Moss Exchange Club, 21st Ann. Rep. York: Coultas and Volans, 1916, pp. 145–76.

† Brotéria, Bot., xi. (1913) pp. 135–43; xiii. (1915) pp. 149–57 (1 pl. and figs.).

‡ Journ. Coll. Sci. Imper. Univ. Tokyo, xxxvi. No. 7 (1915) 51 pp. (24 pls. and 1 fig.).

## Thallophyta.

### Algæ.

(By Mrs. E. S. Gepp.)

**Antarctic Phytoplankton.***—L. Mangin gives an account of the phytoplankton of the Antarctic collected by the second French Expedition (1908–10). The principal elements are the Diatomaceæ; Peridiniales are rare as compared with their occurrence in the Arctic region: and a few Schizophyceæ are found. Of the Peridiniales, *Ceratium* is entirely absent. Of the Diatomaceæ, the author records sixteen species from 62°–70° S. lat., six of which are described and figured as new to science, and raises the total of species recorded for the Antarctic region to about 220—a marked contrast to the 130 species recorded for the Arctic region. The most characteristic Antarctic plankton-diatom is *Corethron Valdiviæ*, which occurs in all but one of the French gatherings, often in dominant quantities (in twenty-five gatherings), and even without admixture (in fifteen gatherings). It is essentially an æstival species, abundant from December to April. Other frequent genera are *Biddulphia*, *Coscinodiscus*, *Eucampia*, *Fragilaria*, *Thalassiosira*. The author treats of the seasonal influence, regional variations, and gives a comparison of the floras of the Arctic and Antarctic. In the former, *Chætoceras* takes the lead with forty-nine species, while in the Antarctic *Coscinodiscus*, with eighty-one species, is far ahead of every other genus.

**Phytoplankton from Celebes.**† C. H. Ostenfeld describes a collection of phytoplankton made by a Dane, Mr. Justesen, attached to the Dutch Indian Government, who was unable to identify the species, but made careful drawings of them. From their examination it becomes evident that the plankton of the Boeton Strait is a rich neritic tropical plankton, resembling much the plankton of the Malay Archipelago as known from Cleve's researches, and that of the Gulf of Siam by the author. The list includes 101 species, of which some are new. New combinations are also formed.

**Cyanophyceæ in France.**‡—H. Coupin writes on the Cyanophyceæ of France, and complains that though work was done on the group by the older botanists Bornet and Flahault, Gomont, etc., there is now a lack of students of the group. Among the 1128 good species known (752 being European), only 347 are recorded from France; while of 104 genera, only fifty are represented. He gives a list of the unrepresented genera. Then follows a list of the genera recorded in France, and lists of the species arranged under their respective habitats—terrestrial, arboreal, on rocks, stagnant water, fresh or salt water, etc.

* Deuxième Expéd. Antarct. Franç. (Paris, 1915) 96 pp. (3 pls.).
† Dansk. Bot. Arkiv, ii. No. 4 (1915) 18 pp. (10 figs.). See also Bot. Centralbl., cxxxi. (1916) pp. 423.
‡ Rev. Gén. Bot., xxvii. (Paris, 1915) pp. 50–9.

The author has completed a Flora of European Cyanophyceæ, but owing to the war it has not yet been printed.

**Chlorophyceæ.***—E. Lemmermann, J. Brunnthaler, and A. Pascher are the authors of the fifth volume of the "Freshwater Algæ of Germany, Austria, and Switzerland." It contains Tetrasporales, Protococcales, and an account of certain uni-cellular algæ of uncertain position, *Coccomyxa* (*Botrydina*), *Glœotænium*, *Keratococcus*, *Elakotothrix*, *Nannokloster*, *Protococcus*, and *Dactylothece*. Two new species are described. A key by Pascher is given to the cellular, not filamentous, green algæ. Notes are given on the possible confusion of certain forms in their determination; also on the occurrence of the species, whether catharol or saprol. Two of the authors are now dead.

**Animal-like Nutrition among Green Algæ.**†—A. Pascher records animal-like nutrition among the amœboid macrospores of *Tetraspora*, *Stigeoclonium*, and *Draparnaldia*. Small *Tetraspora* amœbæ, with broad stout pseudopodia, and having rather a slow movement, took in and devoured certain Bacteria, Cyanophyceæ and Protococcales. Thick-walled spores were not devoured. These amœbæ also assimilated $CO_2$, and were sensitive to light. Macrozoospores of *Stigeoclonium* with amœboid movement were common, and had the structure of normal macrozoospores. They only differ from the swarming macrozoospores through their long period of movement, eight to thirty-six hours. The amœbæ divided up much more quickly than the swarm germlings. Similar results were obtained with *Tetraspora*, though not so quickly. The animal-like feeding in amœbæ of *Stigeoclonium* was very lively. They absorbed Bacillariales, Bacteria, Cyanophyceæ, Chlorophyceæ, and even Desmidiaceæ. Long before germination the foreign body was expelled. In *Draparnaldia*, amœboid stages of the microzoospores were often found, but the animal-like feeding occurred seldom. Chlamydomonads and *Scenedesmus* were taken, never Cyanophyceæ or Bacillariales. Finally, the author discusses the contractile vacuoles. In swarmers, the two vacuoles are mostly in front, fairly near each other. In the amœbæ, especially in the long drawn-out *Stigeoclonium* forms, the space between them may be quite large. The rhythm of pulsation remains the same, however. Sometimes it is possible to divide the long amœbæ into two parts. The vacuole in the portion without a nucleus soon stops pulsating, while the vacuole in the nucleus-containing portion pulsates mostly more rapidly. The tempo is slower, however, if the nucleus-containing portion is relatively small. These small nucleus-containing portions grow to normal size and germinate normally.

**Periodicity of Freshwater Algæ.**‡—E. N. Transeau has made a continuous study of the freshwater algæ of central Illinois during seven

* Süsswasserflora Deutschlands, Heft v. Chlorophyceæ II. Jena: G. Fischer, 1915. See also Bot. Centralbl., cxxxi. (1916) pp. 361–2.

† Ber. Deutsch. Bot. Gesell., xxxiii. (1915) pp. 427 (1 pl.). See also Bot. Centralbl., cxxxi. (1916) pp. 362–3.

‡ Amer. Journ. Bot., iii. (1916) pp. 121–33 (3 figs.).

and a half years, and has analysed some 3,000 samples comprising more than 300 species. He records the following facts as to their periodicity. 1. From the point of view of their complete life histories they may be conveniently grouped into winter annuals, spring annuals, summer annuals, autumn annuals, ephemerals, and perennials. Several examples of each are given. 2. The contradictory results of older observers as to spore-production may be due to neglect of the normal periodicity and vegetative age of the algæ used. 3. Some distinct periods may be recognized in the life history of most freshwater algæ: germination, vegetative development, reproduction, dormancy. 4. Most zygospores, oospores, and aplanospores germinate in the spring: there is, however, germination going on at all times; and a secondary maximum occurs in the autumn. 5. The factors involved in spore-germination are probably as numerous as those of seed-germination. The importance of temperature has probably been over-estimated. 6. The length of the vegetative period in some forms is quite indefinite. In the Zygnemales and Œdogoniales it probably has a definite length under normal conditions. 7. Temperature, light intensity, concentration, and mineral content of the water accelerate or retard the approach of the reproductive period. 8. The normal length of the vegetative cycle in *Spirogyra* is an inverse function of the specific surface of the cells. Possibly this is also true of *Zygnema* and *Œdogonium*. 9. The normal length of the vegetative cycle in species of *Spirogyra* is approximately equal to a constant (sixty-five) divided by the product of the specific surface multiplied by the temperature. 10. The concentrations of the waters in pools, ponds, and surface streams attain their maxima in early spring and autumn, corresponding in general with the periods of heavier rainfall. 11. The lowest concentrations occur in late winter, and at the end of a prolonged drought in summer. 12. The periods of most abundant fruiting of algæ correspond with the periods of high-water levels. 13. The concentration of natural waters at their maximum is so small in comparison with the concentrations of the cell sap that it is doubtful whether it is of any significance in initiating reproduction. 14. In the Zygnemales, lateral conjugation, scalariform conjugation, and aplanospore production appear to be hereditary tendencies rather than the result of environmental conditions.

**Nuclear Division in Spirogyra bellis.***—M. L. Merriman describes the nuclear division in *Spirogyra bellis*, and gives the following summary of her results:—1. Instead of a spireme, as in *S. crassa*, a disk arises from material condensing within the mass of nuclear plasm and central body. This disk is discernible in both living and stained material. 2. No trace of organization is to be seen in the living disk, but fixed material shows it to arise from aggregations of variable appearance and staining qualities. These aggregations are not the chromosomes. The more deeply stained of these bodies arise from the nuclear plasm, the less deeply stained appear to come from the decomposing central body. 3. This sphere of aggregated material gradually changes in shape, becoming a cylinder. The more deeply stained masses become arranged

* Bot. Gaz., lxi. (1916) pp. 311–24 (3 pls.).

upon it as an equatorial band. This band is homologous with the disk seen in living material. As the disk evolves, chromatic bodies, averaging fourteen for this species, are to be seen on the band, while other irregular masses of chromatic material project as loops or pyramidal masses from its edge. These loops or masses represent material from nuclear plasm and central body that has partially amalgamated. 4. No rift appears in the living disk to indicate a sharp splitting of components, but instead the changes in appearance indicate a thinning in the centre, while parts reassemble at either pole. The chromatic bodies in the fixed disks appear as viscous masses that, as they amalgamate, elongate, while other disconnected chromatic masses are discharged into the cytoplasm as the disk separates into the halves passing to the poles. 5. The living disks may be seen sometimes to pass *en masse* to the poles, but more usually they divide their substance into a few continuous strands, to reassemble as disks at the poles of the anaphase. These strands cannot be identified as moving chromosomes, since no units can be discerned in them. As the disks approach the poles, they appear to blend with similar disks apparently evolved from cytoplasm. 6. Each daughter-disk thus arising upon fixation consists of a series of about four rows of tetrahedral masses. In living material the same appears as a translucent rim surrounding a less dense interior. The translucent rim becomes the nuclear plasm, while the central body takes shape within the less dense interior. 7. *Spirogyra*, as exemplified in *S. bellis* and *S. crassa*, may be characterized as having chromatic substance of a polymorphous nature; in the one a disk, in the other a spireme. The nucleolus does not fragment directly into chromosomes, as upheld by so many investigators, but only contributes the less dense substance seen at metaphase, which eventually may be discharged or become partially amalgamated with the chromatin. Hence *Spirogyra*, as regards the constitution and behaviour of its nucleolus, need not be placed in a different category from the remainder of the green algæ or from that of higher plants.

**New Genus of Siphoneæ.***—F. v. Wettstein found in November, on the ploughed land of a cabbage field near Kremsmünster, a colourless species of Siphoneæ, which was harbouring within itself a *Nostoc*. The plant was rare, and was only found in one other neighbouring field. All attempts at culture proved a failure. Each individual consists of a large number of pear-shaped vesicles, bound together by a much branched mass of rhizoids, among which can be distinguished one or several main rhizoids. The lateral rhizoids either throw out vesicles or they penetrate into the ground and develop into much-branched filaments, thus serving as holdfasts and as organs of nutrition. Nowhere were any transverse septa found. The rhizoids are quite full of protoplasm, but on the walls of the vesicles there is only a thin layer. Everywhere in the protoplasm are the small typical Siphoneæ-nuclei. Oil-drops occurred throughout the plant. No chromatophores were present. The relatively thick, distinctly stratified membrane consists of chitin,

* Oesterr. Bot. Zeitschr., 1915, pp. 145–56 (2 pls.). See also Bot. Centralbl., cxxxi. (1916) pp. 131–2.

which substance has never before been recorded for any species of Chlorophyceæ. No reproductive organs were found. Resting spores arise by sprouting from the rhizoids and contain a fat oil. Bodies are also present which are difficult to determine, but might be pyrenoids. The author thinks that his plant is identical with *Botrydium pyriforme* Kütz., and considers that it constitutes a new genus, *Geosiphon*, and represents a heterotrophic form in the Siphoneæ series.

In the vesicles of *Geosiphon*, typical colonies of *Nostoc* were always present. These in the opinion of the author belong to a new species, *N. symbioticum*. It always fills up the space of the mature vesicle left empty by the protoplasm, and is present in all vesicles, large or small. It dies off with the old vesicles, leaving resting-cells which enter the rhizoids and are presumably conducted up to the vesicles by the streaming of the protoplasm. The author considers that this is an interesting case of symbiosis, suggesting an analogy with that of lichens. He points out the presence of chitin in both *Geosiphon* and lichens, and suggests that this substance is connected with the organic nutrition. As regards systematic position, *Geosiphon* represents a strongly aberrant form outside the Siphoneæ series. From a purely morphological standpoint *Geosiphon* forms a link between *Botrydium* and *Vaucheria*.

**Systematic Position of Halosphæra.***—C. H. Ostenfeld has studied *Halosphæra*, and sums up his results as follows:—In March, 1914, the author observed, in the tropical Atlantic, a cell of *Halosphæra*, the contents of which were formed into zoospores of an amœboid or, better, a metabolic character. They were pale yellowish-green with a transparent apex, behind which a carmine eye-spot was found; no flagella were seen. The author proposes to place *Halosphæra* in the Heterokontæ (in the neighbourhood of *Botrydiopsis* and *Botrydium*) for the following reasons:—1. The numerous small yellowish-green chromatophores. 2. Oil, not starch, as result of the assimilation. 3. The cell-wall being built up of two layers. 4. The constitution of the cell-wall being of pectines and siliceous matters. 5. The power of the zoospores to alter their shape. Research is still needed as to the character of the flagella of the zoospores.

**Siberian Algæ.**†—H. Printz publishes the first part of his botanical experiences during the Norwegian Scientific Expedition to Southern Siberia and Uriankailand in the summer of 1914. The author gives in the introduction a short account of the journey in the Sajaner Mountains between Siberia and Mongolia, and describes the orographical, climatic, and vegetative conditions. Then follows a list of the algæ-localities, and of the Chlorophyceæ observed, with the exception of the Desmidiaceæ. Many new species and varieties are described and figured, as well as two new genera of Chætophoraceæ—*Epibolium* and *Lochmium*.

* Bot. Tidskr., ii. (1915), p. 70. See also Bot. Centralbl., cxxxi. (1916) p. 424.
† Kgl. Norsk. Vidensk. Selsk. Skrift., xviii. (Trondjem, 1916) 52 pp. (7 pls.). See also Bot. Centralbl., cxxxi. (1916) pp. 509–10.

**Danish Aerophilous Algæ.***—J. B. Petersen publishes a monograph on the Danish aerophilous algæ. By this term he designated algæ which are able to absorb their water supply from the atmosphere, and are able to sustain life during frequent periods of dryness without passing into a resting-stage. He discusses past work on this subject, and the faculty of certain algæ to support desiccation; also experiments of cultivation under conditions of dryness. The main work is divided into two parts, (A) Diatomeæ, and (B) Chlorophyceæ. Under Diatomeæ the author divides his remarks under historical, methods, habitat, and mode of life; and then goes on to the special part, in which he enumerates all the Danish species, giving critical notes and often figures. In his final remarks he gives the conclusions he draws from his work, which are too long to reproduce here in full. The points with which he especially deals are:—1. Amphibious species, of which he gives a list. 2. Aerophilous diatoms belong to Pennatæ, sub-family Raphideæ, and are therefore endowed with the power of locomotion, and can move to damp places during dry periods. 3. He finds that all aerophilous diatoms are of small, sometimes even minute, size. This would, he considers, tend to preserve their life under dry conditions.

The second part of the work deals with (B) Chlorophyceæ. Their mode of life is fully discussed, and methods of culture. Then follows a list of all the Danish ærophilous species, with critical notes and descriptions of new species.

**Diatoms of Vancouver Island.**†—L. W. Bailey and A. H. Mackay publish the first record of the diatoms of the Pacific coast of Canada. The collections come from the vicinity of the Biological Station at Nanaimo. The authors discuss the planktonic species, genus by genus, and give a list of the non-planktonic forms, and show also which species are common to the Pacific and Atlantic coasts of Canada. They also provide an enumeration of all the species and varieties, as determined by Bailey, Mackay, and O. Kendall, indicating briefly the length and breadth of each in its valval or zonal aspect, the degree of fineness of sculpture, and other characters. Provisional new species and varieties are suggested.

**Saprophytism of Enteromorpha.**‡—E. Häyren describes the saprophytic habits of certain species of *Enteromorpha*. In the harbour region of Helsingfors he found in late summer and autumn a close, well-developed mat of algæ composed almost entirely of *E. intestinalis*, *E. flexuosa*, and *E. crinita*. It extends from the level of mid-tide to a depth of 2–3·5 dm., and is laid bare in the autumn low tides. This mat arises from the influx of drainage into the sea. All stages are found from polysaprobic to pure water. In Tölö Bay, near a great drain-opening, there is a polysaprobic zone (*Beggiatoa*, *Spirilla*, and a

* Kgl. Dansk. Vidensk. Selsk. Skrift., ser. 7, xii. No. 7 (1915) pp. 272–380 (4 pls. and figs.).

† Trans. Roy. Soc. Canada, ser. 3, ix. sect. 4 (1915) pp. 141–73.

‡ Medd. Soc. Fauna et Flora fennica, xxxvi. (1910) pp. 157–61. See also Bot. Centralbl, cxxxi. (1916) pp. 400–1.

large number of bacteria); regions round the drain-opening are strongly mesosaprobic (*Oscillatoria tenuis*, *O. amphibia*, *O. chlorina*, *O. chalybæa*, *Spirulina Nordstedtii*, and *Phormidium autumnale*): while the outer part of the bay is characterized by *Oscillatoria Agardhii* and *Anabæna spiroides*. The author puts forward the following proofs of the saprophytic nature of the above-mentioned *Enteromorpha* species:—1. Where water is badly fouled by the cleaning of fish, *E. clathrata* occurs in quantity. In other parts it is not present. 2. In the rocky hollows of the outermost sea rocks algæ and lichens collect and rot. In such situations low salinity of the water and variations of temperature play no part. 3. In a culture of *E. crinita* and *E. flexuosa* swarmspores settled and germinated on the decaying portions of the mother-plant. Outside Tölö Bay the salinity is greater; and there the mesosaprobic forms of *Enteromorpha* act as indicators of foul water.

**Halymenia.***—F. S. Collins and M. A. Howe describe four new species of *Halymenia* from Bermuda, Southern Florida, and North Carolina. One of these, *H. bermudensis*, is related to *H. floridanus* J. Ag. Two others, *H. Gelinaria* and *H. pseudofloresia*, find their closest affinity in *H. floresia* Ag.; and the fourth, *H. echinophysa*, is allied to *H. actinophysa* M. A. Howe, and has for its type specimens collected by the "Challenger" Expedition, preserved in the Kew Herbarium and in the British Museum under the name of "*Kallymenia reniformis*." The habit and structure of all these four species are described in full detail, and specimens of three of them have been distributed in the Phycotheca Boreali-Americana.

**Lithothamnium tophiforme.**†—C. Samsonoff-Aruffo has continued her studies among the calcareous fossils of the Geological Museum in Florence, and has found specimens of *Lithothamnium tophiforme* Unger from Nettuno, Isola di Pianosa, and Bagni di Casciana, in the *Amphistegina* limestone. She describes in detail the structure of those from each locality. Although her plants lack the reproductive organs, which are of importance in their diagnosis, their anatomical structure enables them to be referred to Madame Lemoine's fifth section of *Lithothamnium*, under *L. tophiforme* Unger. That species according to Madame Lemoine has as synonyms *L. soriferum* Kjellman, *L. nodulosum* Foslie, and *L. fornicatum* Foslie. The species has been found as a fossil by Unger in the limestone of Leitha; and living, by Foslie and Kjellman in the N. Atlantic along the coast of Norway, in the White Sea by Gobi, on the Iceland coast by Stroemfelt, and in Greenland by Rosenvinge. The importance of the present record in Mediterranean Pliocene lies in the connecting link which it forms between the middle Miocene and the present day.

* Bull. Torrey Bot. Club, xliii. (1916) pp. 169–82.
† Atti R. Accad. Lincei, ser. 5, xxv. (1916) pp. 335–9.

## Fungi.

(By A. Lorrain Smith, F.L.S.)

**British Phycomycetes.***—J. Ramsbottom has published a series of papers dealing with this group of fungi. He gives a synoptic list, in which he includes Mycetozoa, Phytomyxineæ, and Phycomycetes with their genera, and a fourth list of species in the genera of the latter. In a second paper he discusses the various debatable genera and species in regard to their history and nomenclature, and in a further contribution to the subject he publishes notes on the history of their classification, and places on record a series of observations by early students of the Microscope, struggling with imperfect powers and the many new facts disclosed to them by their magnifying glasses. The various systems of classification up to the present day are also set forth and commented on.

**Observations on Hyalospora Polypodii.**†—E. T. Bartholomew has studied the life-history of this fern-rust from fresh material both in the field and in the greenhouse. The sori seemed to differ according to the condition of the weather; they were coloured pale grey in cloudy weather, but soon became a bright orange when the sun appeared. The mycelium in the host-tissue formed a loose mat of hyphæ, the cells of which were binucleate. The spores are borne on short stalks, and are of two kinds, thin-walled and thick-walled. The author discusses the theories as to the meaning of these differences in the spores.

**Uredineæ.**‡—J. C. Arthur, in a fourteenth report, gives the result of his cultures of plant-rusts during the year 1915. He collected many specimens of *Puccinia seymouriana* on *Spartina*, but failed to induce growth in the spores or to obtain infection. He was unable to account for this absence of viability. A number of successful cultures were obtained with other species. *Puccinia extensicola* taken from *Dulichium arundinaceum* developed pycnidia and æcidia on *Solidago*, but failed to infect *Aster*; *P. Grossulariæ* collected on *Carex tenuis* formed pycnidia and æcidia somewhat sluggishly on *Ribes cynosbati*; *P. Eriophori*, a new record for America, was found on *Senecio aureus*, and the transfer to *Eriophorum viridi-carinatum* was successfully made; *P. Argopyri* produced æcidia on *Thalictrum*, though not on other Ranunculaceæ Successful cultures were also made with *P. Asperifolii*, *P. subnitens*, and *P. Windsoriæ*.

These results all confirm work previously done. In addition, a series of cultures are reported for the first time: *Puccinia tumidipes*, which formed teleutospores on *Lycium pallidum*, and produced uredospores and pycnidia on *L. vulgare*. *Puccinia Distichlidis*, *P. Montanensis*, and

* Trans. Brit. Mycol. Soc., v. 2 (1916) pp. 318–59.
† Bull. Torrey Bot. Club, xliii. (1916) pp. 195–9 (3 figs.).
‡ Mycologia, viii. (1916) pp. 125–41.

*Uromyces Hordei* were used to infect alternate hosts, with successful results.

J. F. Adams * describes some instances of internal uredinia. Usually the spores are liberated by the bursting of the cuticle lying over the sori. Internal æcidia were reported in *Puccinia angustata* on *Lycopus virginicus*, and internal uredinia of *Dicæoma poculiforme* on rye. In the latter case the spores were liberated into the hollow stem. Internal uredinia were found by the writer in the tissues of *Nigredo caryophyllina*. The leaves of that plant are succulent, and allow a wide ramification of the rust mycelium ; the internal part of the mesophyll was occupied by uredosori with well-developed spores.

Norman G. Hadden † has collected a number of Uredineæ in North Devon. Some of them are new records for Great Britain, others are very rare species. The species were all obtained in the neighbourhood of Lynton. He has found *Uromyces striatus* on *Trifolium procumbens*, and *Cronartium quercuum* on a new host, *Quercus Ilex*.

Five new species of *Ravenelia* are described by W. H. Long ; ‡ three of them from Texas, one from Florida, one from Arizona. They all grow on Mimosaceæ, and one of them, *R. thornberiana*, usually forms small witches' brooms, consisting of a rather dense interwoven mass of abortive branches. Four other species of the genus have been described as also giving rise to "brooms."

E. C. Stakman and Louise Jensen § have made infection experiments with Timothy rust, *Puccinia phleipratensis*. They were able to inoculate it on to *Avena*, *Hordeum*, *Secale*, *Dactylis*, *Elymus*, *Lolium*, and *Bromus*. When the spores produced were compared, some variation was noted.

Florensa y Condal ‖ has reported a very serious outbreak of rust on rice (*Puccinia Oryzæ*) in the Ebrodelta district in Spain. This was due to a number of causes—diseased seed, bad methods of planting and manuring, &c. The result was a complete failure of the rice crop. Many suggestions are made for the avoidance of the disease in future seasons.

K. von Keissler ¶ describes a wide-spread infection of *Galanthus nivalis* by the rust *Puccinia Galanthi*. The spore pustules appear on the under side of the leaves in small spots, or cause a whitening of the leaf which makes the fungus easy to be detected.

**Crocysporium.****—The single species, *Crocysporium torulosum*, has been considered a Hyphomycete, but L. Plantefoil has made a cultural study of it, and considers that it is an imperfect Basidiomycete. It grows on rotten wood, which it covers with a white powdery felt. It was figured and named by Corda, *Ægerita*. It is the presence of clamp con-

* Mycologia, viii. (1916) pp. 181–2 (1 pl.).
† Journ. Bot. liv. (1916) pp. 52–4.
‡ Bot. Gaz., lxi. (1916) pp. 417–24.
§ Journ. Agric. Res., v. (1915) pp. 211–6.
‖ Intern. Agrar. techn. Rundschau, vi. No. 3 (1915) pp. 514–5. See also Bot. Centralbl., cxxxi. (1916) pp. 348–9.
¶ Oesterr. Bot. Zeitschr., lxv. (1915) pp. 236–8. See also Bot. Centralbl., cxxxi. (1916) pp. 406–7.
** Rev. Gén. Bot., xxviii. (1915) pp. 97–116 (10 figs.).

nexions in the mycelium and of binucleate cells that proved the affinity of this fungus.

**American Basidiomycetes.*** — W. A. Murrill publishes a coloured plate of five species of Agaricaceæ, with full descriptions of the plants. The present series includes five *Russulæ*, most of them European as well as American. Murrill is careful to tell the kind of woods in which the species commonly grow.

**British Mycology.†**—An account is published of two forays of the British Mycological Society: one of these at Baslow in Derbyshire in the end of May, 1915. As usual the gatherings of fungi in early summer belonged to the Ascomycetes and parasitic fungi rather than to the Basidiomycetes. Some species new to Britain were found and one new species, *Dermatea nidulariformis*, described by Rea. About 155 species were recorded.

A second foray in the end of September was held at Swansea, and resulted in the collection of 397 different species, the Basidiomycetes figuring largely in the list; 200 species were new records for the Swansea district, several being new to Britain.

E. F. Linton ‡ has published two accounts of the fungi of East Dorset. In one he gives a careful account of the habitat of each plant as well as the locality. There are examples from all the different groups, including six species of Mycetozoa.

In the second paper,§ which includes a large number of species, the habitat and locality are also given. Only the Agaricaceæ are so far dealt with. The district worked over is almost entirely on a tertiary formation, and light sandy soils preponderate. There is also some chalk and a strip of heavier soils.

Somerville Hastings ‖ publishes an account of the "Fungi of Bare Pine Woods" as exemplified at Oxshott Heath. The most abundant fungi in that locality are *Paxillus involutus*, which occur singly or in pairs uniformly scattered over the area; *Flammula sapinia* grouped rather thickly round the pine trees, and in addition close groups of *Boletus bovinus* and *Hygrophorus hypothejus* growing ten or twenty together.

E. A. Rea,¶ in her presidential address to the members of the British Mycological Society, gave an account of the progress in illustrating fungi. She passed in review the various mycologists who have enriched our knowledge with their careful drawings, and she comments on the art and style as well as on the scientific knowledge of the various artists. The first known illustration was found on a fresco at Pompeii, and has been identified as *Lactarius deliciosus*. The next, also a fresco painting, was depicted on a chapel near the Castle of Plaincourault in the Indre, France. There follows a long list of botanists who have devoted their artistic powers to portraying these elusive plants.

* Mycologia, viii. (1916) pp. 121–4 (1 pl.).
† Trans. Brit. Mycol. Soc., v. (1916) pp. 187–92, and 196–207.
‡ Proc. Dorset Nat. Hist. Antiq. Field Club, xxxvi. (1915) pp. 148–96.
§ Journ. Bot., liii. (1915) pp. 313–21.
‖ Selb. Mag., xxvii. (1916) pp. 63–7 (5 figs.).
¶ Trans. Brit. Mycol. Soc., v. 2 (1915) pp. 211–28.

**New British Fungi.***—J. W. Ellis records a number of microfungi new to this country, collected in Cheshire or Derbyshire; one species *Ascochyta oleracea*, a parasite on *Brassica campestris*, is new to science.

Another list of new or rare microfungi is contributed by A. Lorrain Smith and J. Ramsbottom. Many new genera and species are added to the British Fungus Flora, and the fungi described in various other periodicals are brought together. The species were collected in many different localities, and a considerable number are new to science. Many of the latter were collected by D. A. Boyd in Ayrshire.

Carleton Rea also publishes a list, mostly of the larger fungi, with critical notes. Most of them are new to this country, and a few are new to science; the latter are illustrated by a coloured plate.

G. K. Sutherland adds another series of microfungi found on marine algæ. He describes a new genus *Lulworthia*, a Pyrenomycete. The spores are long and curved. It was found on the fronds of *Fucus vesiculosus* at Lulworth Cove.

**Fungi of South Australia.**†—T. G. B. Osborn publishes a list of about forty species of microfungi, most of them parasitic on the higher plants. He refers to the Commonwealth regulations for preventing the introduction of diseased plants, as most of the fungi recorded have been brought into the country with the plants on which they grow. One of the most interesting records is that of *Entorrhiza Solani* which causes a wilt of tomato-plants.

**New Italian Fungi.**‡—L. Maffei has added four new species to his previous lists of Ligurian Fungi. They are microfungi parasitic on plants of considerable importance. *Pleospora Briosiana* attacks the leaves of *Bignonia* and induces spots of various forms: *Phomopsis Cocculi* forms spots on the leaves of *Cocculus laurifolius*: *Macrophoma Yuccæ* and *M. Cinnamomi-glanduliferi* also cause spotting of the leaves of their respective host-plants. These fungi not only disfigure the leaves but lower the vitality of the plants.

**Fungi from Mexico.**§—Paul C. Standley publishes the list of fungi collected by him during three different years. Most of them are parasitic forms, chiefly of Uredineæ and Ustilagineæ, but other groups of microfungi are also well represented. Some of the fungi were collected from a number of localities. The larger majority of the species are European as well as American. One new Uredine, *Æcidium Cockerellii*, is described by J. C. Arthur.

**Fungi from Persia.**‖—R. Gonsalez Fragoso has determined a number of microfungi collected by Martinez de la Escalera, who obtained them mostly from high altitudes. They are all parasitic species, and several of them—Pyrenomycetes or Sphæropsideæ—are new to science.

* Trans. Brit. Mycol. Soc., v. 2 (1916) pp. 228–62 (2 pls. 1 col.).
† Trans. and Proc. Roy. Soc. South Australia, xxxix. (1915) pp. 352–6.
‡ Atti Real. Acad. Lincei, cccxiii. (1916) pp. 339–40.
§ Mycologia, viii. (1916) pp. 142–77.
‖ Boll. Hist. Nat., xvi. (1916) pp. 167–74.

**Anatomical Study of Java Fungus Galls.***—W. Szafer describes the effects produced by parasitic fungi on the leaves of species of *Elsinoë*, and a still fuller account of the galls on *Diospyros* due to *Æcidium rhytismoides*. Pycnidia appear first developing in the palisade tissue—there is tangential division in the pith cells, then the epidermis cells on both sides of the leaf become covered with a black pigment, while the outer walls increase in thickness. The deeper layers of the increasing mesophyll become also thick-walled, as if filled with liquefied stone-cells. This layer forms a protection for the deeply sunk æcidia. As the pycnidia decay and fall out, the place is filled with thick-walled sclerenchyma. These tissues split up and allow the escape of the mature æcidia, leaving a hole in the leaf.

**Studies of Fungi.**†—J. Ramsbottom has published a review of work done on the cytology of fungi during recent years. Many papers have been published during the time, and the survey includes studies of Phycomycetes, especially Entomophthoreæ and Protomycetaceæ, one of the most recent papers being by Jael in 1908, who worked at *Taphridium umbelliferarum*. Ramsbottom finds that no decision can yet be made as to the systematic position of this family. Most attention has been given to the Ascomycetes. There is as yet little agreement among students as to the interpretation of cytological phenomena in that class of fungi. The controversy centres round the number and place of nuclear fusions in the fertile tissues. Ramlow, one of the most recent students of the subject, decided that in *Ascobolus immersus* there was no nuclear fusion until the formation of the asci. A more recent paper by Killian on *Venturia inæqualis* is somewhat vague. He found a trichogyne, and copulation between that organ and the ascogoneous cells. Papers on Uredineæ and Hymenogastrineæ are also analysed; the value of morphological studies for systematists is emphasized.

**Diseases of Plants.**—W. H. Long‡ describes a disease of *Pinus ponderosa* known as heart-rot or red-rot, but differing somewhat from that disease, which is caused by *Trametes Pini*. The one he deals with he names western red-rot, and finds three stages in its development:—(1) the affected heart-wood remains firm, but shows reddish to dark brown discoloured areas; (2) the heart-wood becomes deliquefied and grey; and (3) the heart-wood crumbles and disappears. The disease is a wound disease, and the older the tree is the more liable it is to attack.

Vittorio Peglion§ has described the attack of *Photinia serrulata* by an *Oidium* sp., and the wintering of the fungus in the buds of the host-plant; those inhabited by the parasite developed very late, and the under side of the bud-scales was covered with the conidiophores and conidia of the *Oidium*.

* Bull. Acad. Sci. Cracovie, sér. B, 1915, pp. 80–5 (4 pls.). See also Bot. Centralbl., cxxxi. (1916) pp. 446–7.
† Trans. Brit. Mycol. Soc., v. 2 (1916) pp. 271–303.
‡ Mycologia, viii. (1916) pp. 178–80.
§ Atti Real. Acad. Lincei, cccxiii. (1916) pp. 341–2.

Malusio Turconi * describes a disease that attacked a fine bamboo (*Bambusa mitis*) in the Botanic Gardens at Pavia. The first symptoms of the disease were brown spots or streaks on the stalks, mostly towards the apex, which finally became dotted with black pustules. Turconi found both stages of the fungus—*Scirrhia Bambusæ* sp. n., the perfect ascigerous stage, and the pycnidial stage, *Melanconium Bambusæ* sp. n. He proved satisfactorily the parasitic nature of the fungus by successful infection experiments on other species of *Bambusa*.

Vittorio Peglion † contributes a study of the morphology and the conditions of development in *Sclerotinia trifoliorum*, a disease of clover. Numerous sclerotia were formed on the clover plants, and from these were obtained apothecia and spores. Cultures were made in artificial media, and a conidial stage was produced resembling a *Verticillium*. The author gives various data as to the prevalence and virulence of the disease in Italy and other countries.

## Lichens.

(By A. Lorrain Smith, F.L.S.)

**Antarctic Lichens** ‡—Hue has worked out in great detail the lichens brought back by the Second French Antarctic Expedition. He states that it is the most important collection yet made in those regions, and especially praises the specimens: large blocks of stone were brought home covered with the various species, and showing the associations of the different plants. These rocks are often entirely covered with crustaceous species which grow there to perfection, being undisturbed by snails or insects; it is also possible to trace their development from the earliest granules to advanced stages of thalline growth.

Hue lists in all 126 species, but as 15 of these came from the Magellan regions, only 111 are truly Antarctic. Of these 90 are new to science, 29 belonging to the genus *Buellia*. He emphasizes the need of anatomical investigation in order to determine lichens with accuracy. By anatomical examination he proves that *Umbilicaria Dillenii* does not occur in the south; the plant so named is a new species, *U. rufidula*, or rather it belongs to a new genus, and is now *Charcotia rufidula*.

**North African and Italian Lichens.**§—C. Zanfrognini has worked out a collection of lichens from Libya made by A. Vaccari and others during the Italian war in that province. Most of them are fairly well-known crustaceous species of *Verrucariæ*, *Lecideæ*, *Lecanoræ*, &c., and are accompanied by notes on development, &c.; some of them are very fully described.

* Atti Real. Acad. Lincei, cccxiii. (1916) pp. 528–32.
† Atii Real. Acad. Lincei, cccxiii. (1916) pp. 521–4.
‡ Charcot's Deuxième Expéd. Antarct. Fr. (1908–10). Lichens (1915) 202 pp. (26 figs.).
§ Atti Real. Ist. Ven., lxxiv. (1914–15) pp. 1071–1101.

In another paper * the author describes a series of lichens collected about the same time also by Vaccari in the Island of Lodi. They are all saxicolous lichens. Zanfrognini has added various biological and systematic notes on the different species.

**Fruit Development in Solorina.**†—Fernand and Mme. Moreau publish an account of their research on the apothecium of *Solorina.* In the first stages the upper cells of the gonidial hyphæ form one or more layers of short cells containing one or two nuclei, but mostly one only; these cells give origin to the paraphyses which grow up towards the cortex. When the paraphyses have reached a certain stage of growth ascogenous hyphæ appear, also formed from the gonidial hyphæ; the cells are uninucleate, but the upper cells become binucleate and larger. They spread out at the base of the paraphyses, and then produce the asci at their tips or laterally, but there is no crook formed. In each ascus two nuclei fuse, and spore-formation follows. There are only four spores, but each divides into two cells.

**Lichens of Bermuda.**‡—Lincoln W. Riddle publishes a list of all the known species of lichens from this island. The collections on which he has worked have been made at different times, and from them he has secured thirty-six genera, with eighty-six species and varieties. Ten of these species are new, and so far endemic. The new species are crustaceous forms, with the exception of one *Collema*.

## Mycetozoa.

(By A. Lorrain Smith, F.L.S.)

**British Mycetozoa.**§—Two lists of Mycetozoa collected by members of the British Mycological Society have been published, with notes. The first, by W. B. Allen, contains the species collected at Baslow, Derbyshire, in the end of May, 1915. A season of abnormal drought was unfavourable to the growth and presence of these organisms. Among the more interesting finds were *Lindbladia effusa*, new to Derbyshire, and a variety of *Trichia Botrytis*, later described as var. *cerifera* in a paper by G. Lister on Australian species.

**Mycetozoa of the Gower Peninsula.**‖—The species included in the list compiled by G. Lister were mainly collected during the autumn fungus foray of the British Mycological Society to Swansea. The hunting-ground included many mixed woods, and although no specimen of any striking interest was collected, a very fair number—forty-seven in all—was collected. *Lamproderma arcyrionema*, on dead wood, was a new record for Wales; though widely distributed over the world it is uncommon in the British Isles.

* Atti Soc. Nat. Mat. Modena, ser. 5, ii. (1915) 8 pp.
† Comptes Rendus, clxii. (1916) pp. 793–5.
‡ Bull. Torrey Bot. Club, xliii. (1916) pp. 145–60.
§ Trans. Brit. Mycol. Soc., v. (1916) pp. 192–5.
‖ Trans. Brit. Mycol. Soc., v. 2 (1916) pp. 208–10.

## Schizophyta.

### Schizomycetes.

**Pathogenicity of Bacillus alcaligenes fæcalis.***—A. Rochaix and H. Marotte report two interesting cases of blood-stream infection with *Bacillus alcaligenes fæcalis*. The patients presented symptoms of gastro-intestinal infection. During the first two or three days of the illness the temperatnre varied between 39° C. and 40° C., and gradually regained the normal after about ten or twelve days. Hæmocultures, made the day after admission to hospital, were positive: a second culture made, in one case, six days later was negative. The bacilli thus isolated, agglutinated the serum of the patients in dilutions of 1 in 200 and 1 in 500, after several artificial cultivations. Moreover, the serum of the first case agglutinated the bacillus of the second case in a dilution of 1 in 200, and the serum of the second case agglutinated the bacillus of the first case in a dilution of 1 in 1000. The bacilli isolated gave all the cultural reactions of *Bacillus alcaligenes fæcalis*. Similar cases have been reported by Petruchsky in 1912, Fürth in 1913, and Straub and Krois in 1914.

**Coccobacillus buccalis.**†—Mme. A. Panayotatou has separated from two cases of ulcerative stomatitis an organism which appears to be the cause of that condition, frequently met with in Egyptian children as a result of bad hygienic circumstances. The organism stains well with the ordinary aniline dyes and is Gram-negative, non-motile, and grows well on the ordinary laboratory media. It produces a uniform cloudiness in broth after twenty-four hours. At the surface a delicate scum adherent to the sides of the tube is formed, while at the bottom of the tube an abundant greyish precipitate is produced. Upon agar slopes the growth is thick and viscous, and bubbles of gas are formed in deep agar stabs. No liquefaction of gelatin is produced. The organism forms acid and gas in lactose, saccharose, raffinose, mannite, glucose, and maltose, and does not hæmolyze rabbit erythrocytes. It is a strict anaerobe. Intravenous inoculation of rabbits produces hæmorrhagic stools and intestinal hæmorrhages. Diarrhœa persists for several days, the temperature oscillating between 39·5° C. and 39° C. The experimental animal makes a complete recovery. The cultures can, however, be exalted by passage, so that a half agar slope of culture is lethal for the rabbit in some thirty hours. Subcutaneous inoculation produces œdema and injection of the skin at the end of twenty-four hours. On the third day ulceration takes place accompanied by a dirty and grumous discharge, which forms crusts on drying. The organism can be recovered from the ulcerated surfaces in pure culture.

**Morphology of Bacillus icterigens.**‡—S. Costa and J. Troisier have isolated an organism, belonging, it is believed, to the Actinomycetes

* C.R. Soc. Biol. Paris, lxxix. (1916) pp. 316–8.
† C.R. Soc. Biol. Paris, lxxix. (1916) pp. 291–2.
‡ C.R. Soc. Biol. Paris, lxxix. (1916) pp. 330–2.

group, from the lesions of infective jaundice. The organisms appeared in the liver, blood, fæces and urine. The bacilli generally appear as long, granular, incurved filaments—particularly so in the muscular lesions, small liver abscesses, myocardium and lungs of experimentally infected rabbits. The microbe grows best in calf- or ox-liver broth. In these media refractile ovoid thickenings can be seen, two or three in number, and apparently isolated in the bodies of the organisms. The bacilli stain best with carbol-fuchsin, the granules taking the stain better than the rest of the cell-substance, so that the stained organism has a somewhat striated appearance. The shorter forms show bipolar staining. All forms stain indifferently with methylene-blue and carbol-thionin, and the granules do not stain with Sudan 111, iodine, or Neisser's stain. *Bacillus icterigens* does not form chains, is non-acid-fast, and is quite Gram-negative. The short forms exhibit slight oscillating movements (Brownian movement), but are, however, non-motile. "The enumeration of these characters of the *B. icterigens*, added to the odour of its cultures, appears perhaps sufficient to authorize its inclusion in the group of the Actinomycetes."

**Morphology of Bacteria in Leaf Nodules of Pavetta coffra.***—P. Georgevitch has isolated two different species of bacteria from the leaf nodules of *Pavetta coffra* (natural order *Rubiaceæ*). One of the species, which he calls $\alpha$, is very motile, forms spores, and does not branch; the other species ($\beta$) does not form spores, is non-motile, and splits up on artificial media into a number of particles (arthospores) which continue to grow and branch by budding. The bacterium $\beta$ forms a rod 3 to 5 $\mu$ in length and of 1 $\mu$ in thickness; it is irregular in transverse section, and is slightly curved. It grows well on potato at 33° C., and forms pale yellow colonies upon agar, on which medium the bacillus $\alpha$ forms milky white opalescent colonies. Bodies containing chromatic granules (arthospores) are formed by the bacillus $\beta$ by means of a process of segmentation, and are capable of development upon suitable media. They lose their round form and become oval, and two chromatic granules appear on opposite sides of the arthospore, which becomes divided into two equal portions by means of a transverse septum. The arthospore becomes more and more elongated, more septa are formed, the lateral walls invaginate in the neighbourhood of the septa, and the cell breaks up into a new series of arthospores.

* C.R. Soc. Biol. Paris, lxxix. (1916) pp. 411–3.

# MICROSCOPY.

## A. Instruments, Accessories, etc.*

### (1) Stands.

**Bausch and Lomb's Binocular Microscope (Greenough Type).**†—This instrument (fig. 28) is lettered K A. and is described on page 58

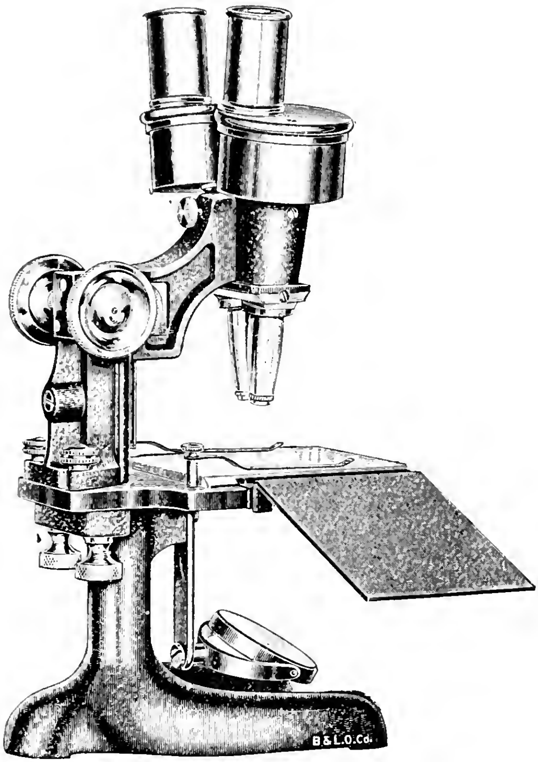



Fig. 28.

of the maker's catalogue. The base is of the modified horse-shoe form and of rounded contour. The pillar is of one piece with the base, and is detachable from the Microscope by removing two binding

* This subdivision contains (1) Stands: (2) Eye-pieces and Objectives; (3) Illuminating and other Apparatus; (4) Photomicrography; (5) Microscopical Optics and Manipulation; (6) Miscellaneous.

† Bausch and Lomb's Catalogue, Microscopes, 111 pp. (many illustrations), Rochester, N.Y., and London.

screws, thus rendering the upper portion of the instrument ready for use in examining large surfaces—the stage, with its plate removed, serving as a base. The arm embodies two special features: (1) It provides for extraordinary range of working distance up to 155 mm., measuring from lower edge of nose-piece to stage; the curved part is adjustable along upright, and can be fixed in any position by the clamping head shown in opening of curved part; the working distance can also be decreased by detaching curved part from upright and body-tubes, inverting and replacing it, for focusing some distance beneath stage. (2) The entire arm with body-tube can be removed and used on a stand consisting of base-plate and vertical pillar (listed as K B), it being only necessary to place a short post, as provided, in socket at back of arm. The body-tubes are a combination of two Microscope tubes, the upper parts of which are fitted with porro prisms, and are rotatable for adjusting position of eyepieces to observer's pupillary distance; one image merges with the other, and the object is seen stereoscopically, erect and not transposed; the nose-piece provided takes self-centring slides, upon which each pair of objectives is mounted, with means for centring one with the other; one of each pair of objective mounts provides for adjustment to compensate for differences between the observer's eyes. The focusing adjustment is by standard rack-and-pinion, the pinion heads being so placed with relation to body-tubes as to eliminate completely the inconvenience caused when these parts are close together; the location of rack slide is such that it is not immersed when working with water-immersion objectives. The stage is of metal with large rectangular aperture provided with two removable plates, one of glass 80 × 95 mm., the other of metal, same size, with aperture 22 mm. in diameter, underneath which a rotating plate provides white opaque, black opaque, and ground-glass stops, or clear aperture; the stage is also provided with detachable metal hand rests and spring clips. The mirrors are plane and convex, 50 mm. in diameter, adjustable in two planes in a fork; they are mounted on a swinging arm, and are not easily removable.

### (3) Illuminating and other Apparatus.

**New Mechanical Stage.***—Katharine Heanley, who describes this new device, says that in addition to the usual advantages of a mechanical stage, the invention here illustrated (fig. 29) is easily fixed to and

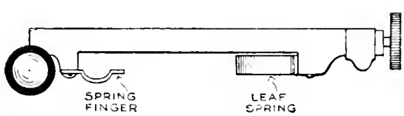



Fig. 29.

unfixed from any Microscope. This is effected very simply. To the right, on the under side of the machine, is a strong curved leaf spring attached at its proximal end to a firm crossbar; on the left, at a

* Lancet, July 15, 1916, p. 110 (1 fig.).

convenient distance, are pivoted two spring fingers. The machine is slipped over the anterior edge of the stage, the curved spring firmly presses the right edge of the stage, while the two spring fingers grip its left edge and under surface. This construction is sufficient to hold the machine immovably on the stage, and is adapted to engage stages of different widths within the limits of stage sizes usually employed with Microscopes.

### (5) Microscopical Optics and Manipulation.

**Spirochæta pallida.***—E. M. Nelson shows a rough sketch (fig. 30) of *Spirochæta pallida* made under a power of 4000 diameters, which illustrates two details hitherto unknown. They are (1) the long whip-like flagella, and (2) the beaded structure of the organism. The length of the organism is $\frac{1}{2400}$, the width of the helix about $\frac{1}{30000}$, the pitch of the screw about $\frac{1}{17500}$, the length of the flagellum about $\frac{1}{3000}$, and the thickness of the thread of the body $\frac{1}{65000}$ in. The longest of the organisms measured $\frac{1}{1500}$ in., and the shortest was somewhat less than half that size. The pitch of the screw is very variable. The thickness

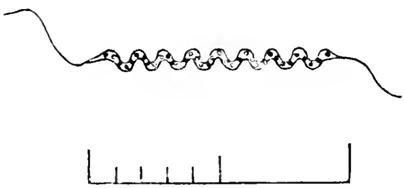


FIG. 30.—Scale, $\frac{1}{2000}$ in. by 4000.

of the thread of the body was corrected for antipoint. The organism does not resemble a spiral, but is like a helical screw. The helix of the one drawn was measured both by a screw micrometer and by the simpler method of extinction; the results were identical. The flagellum is a fine but not a difficult microscopical image, but the visibility requires most careful microscopical work. The image of these was so difficult that it was found impossible to step them with the web of the micrometer. As a rough estimate they may be 110,000 to the in.

**Immersion fluid.**†—E. M. Nelson writes that microscopists should know that it is now almost impossible to procure proper immersion oil for Microscope object-glasses. A proper fluid was invented by Abbe, and was sold by the firms of Winkel and Zeiss. The "cedar oil," as commonly sold, and also the immersion fluid of Leetz, have not the requisite optical properties, therefore objectives immersed in them do not yield their best results. The following formula gives Abbe's latest results. The ingredients are three, viz.: (1) White oily tacamaque of Guibourt; (2) oil of cedar (*Juniperus virginiana*); (3) castor oil. The proportions are 29 grammes of tacamaque dissolved in 22 c.cm. of cedar oil, to which are added 14 c.cm. of castor oil.

* English Mechanic, June 2, 1916, p. 371 (1 fig.).
† English Mechanic, June 2, 1916, pp. 370-1.

### (6) Miscellaneous.

**Miniature Dark-room for Use with the Microscope.***—R. T. Hance says that all microscopists prefer to work either at night or in a darkened room. Using the Microscope under such conditions does away with the strain to which both the observing and the unused eye are subjected by the side light, i.e. light coming from sources other than through the tube. When working in darkened surroundings the effect is that of looking at a picture on a screen. The image appears brighter, and objects become clear that under the usual conditions are scarcely visible.

For several years the writer has been trying to devise some method to control the light perfectly, and to do this without necessitating the darkening the whole room. It is desirable that any apparatus for the purpose should weigh little, and (for ease in carrying from one place to another) it should be simple to take apart. It should, of course, be adaptable to every condition. For further convenience of the worker definite places should be present in such an apparatus for the usual microscopical accessories—pens, pencils, drawing and memorandum cards, and lens paper.

The following description is of a miniature dark-room for use with the Microscope fulfilling these requirements. It was designed and made by the writer last fall, and, after a year's use, he has found it to be exceedingly practical in eliminating all the strain that results when the eye is unshielded. In this darkened enclosure the eye not in use is at perfect rest. Moreover, for drawing the light may be controlled so that it is possible always to have light of the same intensity directed on the drawing paper.

*Description* (Fig. 31).—A, Base: $\frac{1}{4}$-in. white pine 12 by 18 in., with a binder of the same wood across each end to prevent warping.

B, Uprights: dowel sticks 1 in. in diameter cut to 18 in. in length.

CC, Rods: common telescoping curtain rods. Each of the rods C is cut 8 in. from the end that ordinarily would be used to fasten it to the window. C is formed of the remainder, of the part between the ends.

D, Wire: a piece of annealed wire $\frac{1}{8}$ in. in diameter about $4\frac{1}{2}$ ft long bent as shown.

*To Assemble*:—One 2-in. screw fastens each upright to the base. The upright on the left can be seen to have two angle-irons aiding in its support, but this is only necessary when the fan is added. Holes are drilled in both uprights to correspond to the diameter of C, which is inserted in them. The rods C are attached by one end to the tops of the uprights by a screw through the eyelet in the rod. Through the eyelet at the opposite end a small rod is passed as shown to prevent the curtains from slipping off. The wire D is fastened to the outer sides of the uprights by means of a single round head screw passed through each flattened end. All the wood and metal-work is painted a dead black.

For many valuable suggestions on the design of the curtains and for the excellence of their construction I am indebted to my mother. (See fig. 32.)

* Trans. Amer. Micr. Soc., xxxv. (1916) pp. 60–4.

The curtains suspended from the rods C and C′ are in four parts, all overlapping each other and fastening together with spring snaps. They are made of the heaviest grade of black sateen doubled. On the right-hand curtain are pockets for pencils and cards. On the left side is a pocket for lens paper. The pocket is provided with a flap to exclude the dust. The upper curtain carried on the wire D is of single thickness. The central curtain is in two parts so that they may be separated to permit light to fall on the drawing board. The left-hand curtain of the central set has a rectangle 1 in. wide by 5 in. high cut from the

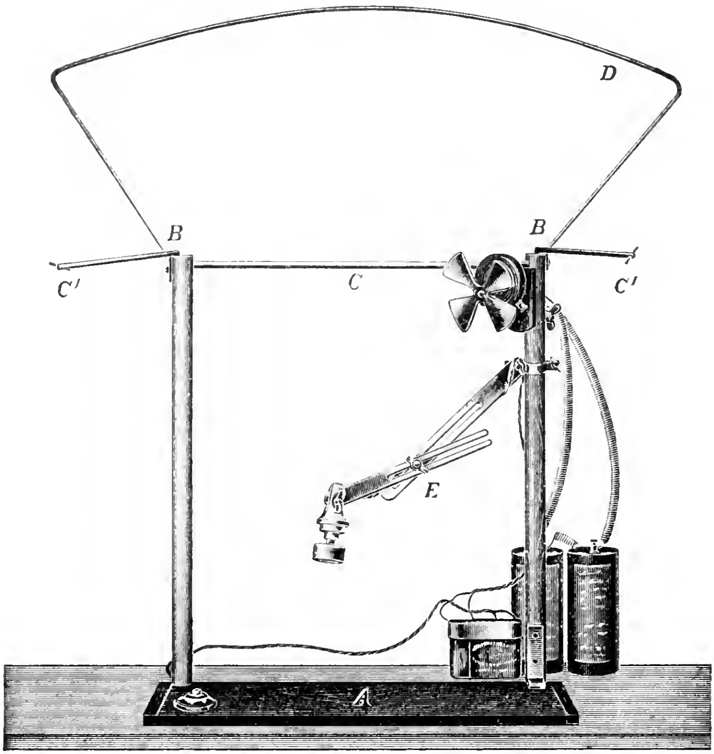



FIG. 31.

centre of the basal portion. Across the top of this aperture is stitched a flap of double thickness, $3\frac{1}{2}$ in. wide by $5\frac{1}{2}$ in. in length. To one corner of the loose end of the flap is attached a tape which passes around the tube of the Microscope and fastens to the other corner of the flap by means of a spring snap.

With the Microscope surrounded by these curtains it is impossible to read the figures on the mechanical stage, and so the small light (fig. 31, E) was installed. This can be adjusted by means of sliding rods locked with winged nuts to hang directly over the stage. The lamp arm is attached to the right-hand upright by means of a collar

made of two pieces of brass stripping fastened on each side of the pillar with a thumb-screw. The lamp is a small tungsten bulb set in a porcelain socket. The shade or reflector, shown in the photograph, was taken by an old tubular flashlight. A small three-cell pocket battery furnishes the current, which is controlled by a push-button at the left of the Microscope. The same battery has lasted for very nearly a year now without visible signs of weakening.

The fan shown in both photographs is a toy motor equipped with a $4\frac{1}{2}$-inch blade. The motor is operated on two dry cells. It is fastened to a wooden base that is inserted in a slot in the upright and clamped tight by means of a winged nut. This fastening permits the fan to be

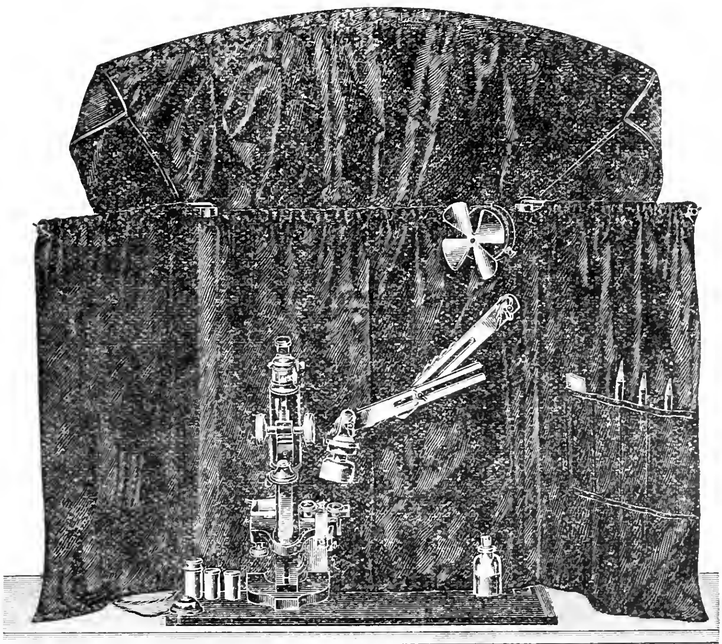


FIG. 32.

tilted up and down, while the single screw securing the fan to the base allows a left and right rotation. The air current may thus be directed on any spot desired.

*Operation.*—For Microscope illumination with this dark room a concentrated filament Mazda frosted globe is used. This globe is placed behind the slit in the central curtain, and the Microscope is put in position on the opposite side. The flap covering the slit is then snapped about the tube of the Microscope just above the nose-piece. The slit through which the light comes is so narrow that the stage of the Microscope effectively shields the eye from the light coming through the lower part of the slit, while the flap takes care of all other dispersion.

In the average room having windows on only one wall the side curtains can be left wide apart. In places where the worker is almost surrounded by windows it is of advantage to draw the side curtains so close that there is just room for the observer's head to enter. The telescoping rods supporting the side curtains permits these to be narrowed or widened to suit the circumstances. The top curtain works to or from the microscopist, and is frequently convenient in cutting out the light from the upper parts of the windows.

Light on the drawing paper is obtained by separating the lower portions of the central curtains from each other and fastening them back. The bulb illuminating the Microscope then throws its light over the right-hand side of the base. A constant intensity of illumination is in this way assured.

The fan is a luxury—possibly an unnecessary one—but in very warm weather, or on days when a few flies persist in maintaining their position at all hazards on top of the writer's head, he has not been at all sceptical as to whether the luxury was unnecessary or not.

**Microscopic Structure of Semi-permeable Membranes and the Part played by Surface Forces in Osmosis.***—F. Tinker thus summarizes his researches:—1. The common precipitation semi-permeable membranes are composed of small precipitate particles ranging from $0 \cdot 1$ $\mu$ to 1 $\mu$, these particles being closely packed together. Each of these precipitates is, however, not simple in structure, but is itself an aggregate formed by the flocculation of sub-microscopic colloidal particles. The particles composing the membrane are smallest in the case of copper ferro-cyanide and prussian blue. 2. Precipitation membranes show most of the properties of gels, as ordinarily prepared, both in their method of formation and in the changes they undergo in various solutions. Like ordinary gels they are possessed of great tensile strength, which varies in membranes of different kinds. Their stability in the colloidal condition also varies greatly. But, although they show the physical properties of gels, they have not the same mechanical structure, the membrane being much more closely knit together than the gel proper. 3. The pores in a copper ferro-cyanide membrane range from 8 to 60 $\mu\mu$ in diameter, the average diameter being from 15 to 20 $\mu\mu$. The pore size is too great for the membrane to act osmotically by exerting a selective mechanical blocking action. 4. The order of a series of membranes in pore size is the same as that of their efficiency in semi-permeable membranes. Copper ferro-cyanide and prussian blue are the most efficient membranes, and they have also the smallest pores. 5. There is a very close connexion between the osmotic properties of a membrane and the extent to which the membrane capillaries are under the control of surface forces. Osmotic effects are probably the result of selective adsorption phenomena occurring at the surface of the membrane and in the capillaries, the membrane being relatively impermeable to solutes which are negatively adsorbed, but permeable to solutes which are positively adsorbed.

* Proc. Roy. Soc., xcvi. (1916) pp. 357–72 (6 figs.).

## B. Technique.*

### (1) Collecting Objects, including Culture Processes.

**Hæmoculture of Gonococci.†**—P. Danila reports a case of gonorrhœal septicæmia in which he succeeded in isolating the organism in question from the blood-stream. Ordinary broth without the addition of serum or ascitic fluid, ascitic agar, and ordinary agar were inoculated with blood from the median vein and incubated immediately at 37° C. After forty-eight hours colonies of the gonococci were observed growing in the clot in the broth culture. The other media remained sterile. The articular fluid from the knee-joint, although rich in leucocytes, did not contain gonococci. The patient did not recover.

**New Method of Anaerobic Culture.‡**—J. McIntosh and P. Fildes have constructed an apparatus in which they state anaerobic cultures can be grown with the greatest facility. The culture tubes are enclosed in a receptacle in which is suspended a piece of asbestos or platinum covered with palladium. Hydrogen is then passed into the receptacle by means of a stop-cock. The palladium black causes the hydrogen to combine with oxygen, and the atmosphere becomes quite free from the latter.

A round receptacle made of tin-plate is employed (175 mm. by 125 mm.), to which is adapted a lid with a tap affixed centrally. The contrivance is made impervious to the external air by means of a plasticine luting. The culture tubes are placed in the luted receptacle, the metal cage containing the palladium is then warmed in the Bunsen flame, and the lid firmly adjusted. Hydrogen, under pressure, is then allowed to flow through the tap until the apparatus becomes cold (twenty-five minutes). It is then placed in the incubator. If used for gelatin cultures it is necessary to place a refrigerating mixture in the receptacle at the same time as the cultures. A yet more simple application of this method may be made by employing an Erlenmeyer's flask fixed with a rubber cork through which passes the connexion from the hydrogen tap, the cage containing the platinum-palladium being fixed with a nut to the lower surface of the cork. By these methods the authors have succeeded in producing well-developed colonies of *Bacillus perfringens* and of *B. œdematis maligni* from material taken direct from war wounds containing these organisms. The advantages claimed are as follows:— 1. The method is very simple and rapid, the operation being completed in twenty minutes. 2. The apparatus is always ready for use without previous preparation, and without the employment of any reagent other than hydrogen. 3. All the usual laboratory media can be used without any previous preparation. 4. The strictest anaerobes grow on the surface of the media; for example, the colonies of the tetanus bacillus on serum agar become visible in twenty-four hours.

* This subdivision contains (1) Collecting Objects, including Culture Processes; (2) Preparing Objects; (3) Cutting, including Embedding and Microtomes; (4) Staining and Injecting; (5) Mounting, including slides, preservative fluids, etc.; (6) Miscellaneous.

† C.R. Soc. Biol. Paris, lxxix. (1916) pp. 460–1.

‡ C.R. Soc. Biol. Paris, lxxix. (1916) pp. 293–5.

**Preservation of Living Red Blood-cells in Vitro.***—P. Rous and J. R. Turner point out the practical value of the preservation of red cells for use in serum reactions, culture media, and even for transfusion. One-eighth p.c. gelatin is added to the solution in which the cells are washed, the use of this reagent protecting the cells from mechanical injury. Though gelatin acts as a protective for red cells it is not a preservative of them in any real sense. Cells do not last longer when it is added to the fluid in which they are kept. Lock's solution, though better probably than Ringer's solution, or a sodium chloride solution, as a medium in which to keep red cells is ultimately harmful. The addition of innocuous colloids does not improve it. But the sugars, especially dextrose and saccharose, have a remarkable power of preventing its injurious action, and they possess, in addition, preservative qualities. Cells washed in gelatin (Lock's) and placed in a mixture of Lock's solution with an isotonic watery solution of a sugar remain intact a long time—nearly two months in the case of sheep's cells. The kept cells go easily into suspension free of clumps; they pass readily through filter-papers, take up and give off oxygen, and when used for the Wassermann reaction behave exactly as do fresh cells of the same individual. The best preservation solutions are approximately isotonic with the blood serum. If the cells are to be much handled, gelatin should be present, for the sugars do not protect against mechanical injury.

Different preservative mixtures are required for the cells of different species. Dog cells last longest in fluids containing dextrine as well as a sugar. The mixture best for red cells is not necessarily best for leucocytes.

A simple and practical method of keeping rabbit and human erythrocytes is in citrated whole blood, to which sugar solution is added. In citrated blood as such, human red cells tend to break down rather rapidly, no matter what the proportion of citrate, hæmolysis being well marked in a little more than a week. But in a mixture of three parts of human blood, two parts of isotonic citrate solution (3·8 p.c. sodium citrate in water), and five parts of isotonic dextrose solution (5·4 p.c. dextrose in water) the cells remain intact for about four weeks. Rabbit red cells can be kept for more than three weeks in citrated blood, and the addition of sugar only lengthens the preservation by a little. The result differs strikingly with the amount of citrate employed. Hæmolysis occurs relatively when the smallest quantity is used that will prevent clotting. The optimim mixture has three parts of rabbit blood to two of isotonic citrate solution.

**Anaerobes Isolated from Wounds.†**—Muriel Robertson, working with material derived from gangrenous wounds sent her from Flanders by Major Rowland and others, has succeeded in isolating therefrom *Bacillus perfringens* (*B. ærogenes capsulatus*, Welch and Nuttall: *B. Welchii*, auctt.; *B. phlegmones emphysematosæ*, Fraenkel), *B. œdematis maligni* (Koch), and a bacillus closely related with Hibler's bacillus No. 9, and also allied to Rodella's bacillus No. 3.

* Journ. Exper. Med., xxiii. (1916) pp. 219–37.
† Journ. Path. and Bact., xx. (1916) pp. 327–49.

| Organism | Motility | Spores | Colonies on Agar | Sugar | Milk | Gelatin | Inspissated Serum | Glucose Broth | Mulin |
|---|---|---|---|---|---|---|---|---|---|
| *Vibrion séptique* | Motile, but often non-motile | Central or sub-terminal | — | Acid reaction, gas, pink colour | Acid clot, some gas, no digestion | Liquefied | Not liquefied | — | — |
| *B. perfringens* . | Non-motile | Ditto | Smooth surface colony, lenticular in depth | Acid reaction, much gas, pink colour | Acid clot, much gas, no digestion | Ditto | Ditto | Acid and gas | Acid and gas |
| Hibler No. 9 . | Non-motile or very feebly motile | Endospores attached to long slender rod | Flat, slightly crenated, smooth colony on surface, has lumpy outgrowths in depth | Acid reaction, considerable amount of gas, pink colour | Attacked very slowly, finally acid and clot | Not liquefied | Ditto | Ditto | No change |
| *B. œdematis maligni* | Actively motile | Central or sub-terminal, rarely terminal | Woolly colony, both on surface and in depth | Alkaline reaction, blackened, with putrid odour, digested | Milk digested without clot, but casein may be precipitated in grain | Liquefied | Liquefied | Ditto (not vigorous) | Ditto |
| *B. tetani*. . . | Motile | Endospore, "drum-stick," but clostridial forms present | Ditto | Blackened, with putrid odour | Digested with precipitation of grains of casein which are digested | Ditto | Ditto | — | — |

The preceding table gives the cultural reactions of the three organisms, and also of the "vibrion séptique" (original strain from Pasteur Institute, which appears in reality to be Rauschbrand) and *B. tetani*.

The pathogenic anaerobes may thus be conveniently divided into four groups as follows:—

*Group A.*—The Rauschbrand group (Bacillus of Rauschbrand, Bacillus of Ghon and Sachs, Bacillus of Novy), containing forms which do not digest the proteins; they do not liquefy inspissated serum or produce blackening in meat or "hernbrei" medium. They clot milk without much shrinkage of the clot; they are able to liquefy gelatin; they are usually motile, but this character is liable to variation. Spores are formed in all the media, but an alkaline reaction favours their production; the spores are central or subterminal. The group for the most part is very pathogenic to laboratory animals. They are very strict anaerobes.

*Group B.*—The *perfringens* group contains forms which have very little capacity for attacking the proteins. The strains belonging to this group do not liquefy inspissated serum or blacken meat or "hernbrei." They clot milk, producing a hard tough clot much broken by gas; the reaction is acid, and a strong odour of butyric acid is given off. There is no obvious digestion of the clot. They are non-motile, with the exception of *B. enteritidis sporogenes* (Klein). The colonies are smooth: spores are not formed, except on alkaline media rich in protein and containing a little fermentable sugar. The organisms are pathogenic.

*Group C* (*B. amylobactor*, von Hibler No. 9) may be recognized by their inability to liquefy gelatin; they are incapable of attacking the proteins, and do not liquefy inspissated serum or blacken meat media.

*Group D* (*B. œdematis maligni*, *B. tetani*, *B. botulinus*, *B. cadaveris sporogenes*) may be called the proteolytic group, and is characterized by its very active powers of digesting media rich in protein. Milk is digested usually without the production of clot, though a precipitation of casein may occur; inspissated serum is liquefied, meat media blackened and digested, and gelatin is liquefied; their growth produced a penetrating odour of putrefaction. They are actively motile. The colonies have a characteristic appearance, and grow out in long tangled filaments at their edges. Such members as *B. tetani* and *B. botulinus* are sharply marked off by their characteristic toxins and other peculiarities, but they are none the less closely allied to the rest of the group in their cultural reactions.

The composition of the cooked meat medium and the alkaline egg fluid referred to is as follows:—

*Cooked Meat Medium.*—Eight ounces of bullock's heart, minced very fine and then ground in a mortar; add eight ounces of tap water and heat slowly so as to cook the meat thoroughly; add normal sodium hydrate until the medium is alkaline to litmus. Divide into tubes and autoclave.

*Alkaline Egg Fluid.*—This is a modification of Besredka's medium. The yolk of one egg and the whites of two are beaten up in a beaker; add 6 c.cm. of normal sodium hydrate; add 500 c.cm. of tap water by

degrees. Heat very slowly to 95° C., keeping the mixture at this temperature for about an hour or longer; filter through cotton-wool and muslin. Divide the tubes and autoclave at 115° C. for twenty minutes. This egg fluid may be added to ordinary nutrient broth in the proportions of about 1 to 5. The egg fluid must be added to the broth when both the fluids are cool. The egg fluid may be added to agar at 50° C. All the sugar media should be made up with nutrient broth instead of pepton water. The anaerobes do not grow sufficiently well upon pepton water.

### (4) Staining and Injecting.

**Staining of Bacterial Capsules.***—R. Muir claims that by this method the capsules of bacteria can be stained differentially, while a Gram-positive reaction is also obtained. A thin film of the material is made on a cover-glass, and after drying in the air is fixed for one minute in a saturated watery solution of mercuric chloride. The preparation is then washed in water and in methylated spirit. With wet films the cover-slip is placed film-side downwards in 10 p.c. formalin for two to five minutes. It is then gently washed with water and methylated spirit. The film is covered with freshly prepared Gram-stain of the following composition: Saturated alcoholic gentian violet, 1 part: 5 p.c. watery carbolic acid, 5 parts. The preparation is heated over a Bunsen for a few minutes; when cool, the stain is washed off with Gram's solution, and a little fresh iodine solution is added. After two or three minutes the iodine is washed off with methylated spirit and the washing with spirit repeated. A few drops of clove oil are then placed on the film and the warming repeated. Wash with spirit and then with water. Filter on the film a few drops of solution containing one part each of a saturated watery solution of mercuric chloride, a saturated watery solution of potash-alum, and a 20 p.c. solution of tannic acid. This is allowed to act for five minutes; wash in water and counter-stain for one or two minutes with a saturated watery solution of eosin. Wash in water. Filter on a few drops of saturated watery solution of potash-alum and allow to act for a minute. Then wash, dry and mount, or, in the case of wet fixed films, dehydrate, clear in benzol and mount.

For sections, small pieces of tissue should be fixed in 5 to 10 p.c. formalin for two or three days, and after a few minutes' washing should be transferred to methylated spirit for two or three days to complete the hardening. For removal of the precipitate, which forms in the material thus fixed, place the pieces in a solution containing one part of 1 p.c. aqueous potash solution and twenty parts of 80 p.c. alcohol. The precipitate takes about a week to become removed. Wash thoroughly for several hours in running water, replace in methylated spirit, and keep till required. Embed the tissues in the usual way. The method of staining sections is the same as that described for films, except that the specimen may not require heating after the clove oil is placed on it, and in any event heating need not be prolonged beyond a few seconds

* Journ. Path. and Bact., xx. (1916) pp. 257–9.

in order to complete the decolorization, and that the alcohol used for the dehydration should contain four drops of glacial acetic acid to the ounce.

**Fixation and Staining of Chondriosomes.***—A. Maximow recommends the method of Champy with the "post-chromisation" of Benda. The fragments of tissue are placed for twenty-four hours in a mixture of seven parts of 1 p.c. chromic acid, seven parts of 3 p.c. bichromate of potash, and four parts of 2 p.c. osmic acid. Wash in water and place for twenty-four hours in two parts of acetic acid, and one part of 1 p.c. chromic acid. Wash again for half-an-hour, and place for three days in a solution of 3 p.c. bichromate of potash. Wash once more. Embedding in paraffin gives better sections of chondriosomes than celloidin embedding. The staining method of Kull is considered the best and consists of staining at first with acid fuchsin (Altmann), then thionin, and differentiating with aurantia. The chondriosomes are by this method stained a deep red, while the nuclei take on a purple hue. The protoplasmic ground substance is stained a clear yellowish grey.

### (5) Mounting, including Slides, Preservative Fluids, etc.

**Substitute for Canada Balsam.**†—R. Borrow states the gum from *Pinus tæda* is a good substitute for Canada balsam. When prepared for use it has a refractive index of about 1·626. This makes it specially useful for mounting diatoms. It is prepared as follows. Put the gum into a wide-mouthed bottle and add just sufficient alcohol to cover it. When dissolved pour off the clear part into another bottle and add oil of cassia in the proportion of one of cassia to three of gum. To use it for mounting diatoms, dry the specimens on a cover-glass in the usual way, place on the hot-plate, and heat until bubbles are caused. When these cease to appear, apply a lighted match quickly, which will clear all the remaining bubbles. Now push the cover-glass on to a cold-plate of iron or earthenware, when the gum will immediately harden. Warm the slide and place on it the cover-glass. The gum will melt and allow the cover to settle down, or slight pressure may be applied. Put on the cold-plate again. In a minute or so the gum which has oozed out may be chipped off with a sharp-pointed knife.

### (6) Miscellaneous.

**Amœbæ in Pyorrhœa alveolaris.**‡—J. Mendel has investigated the question of the pathogenicity of the *Entamœba buccalis* in infective conditions of the mouth, and has come to the following conclusions. The presence of amœbæ in the buccal cavity of man is a commonly observed circumstance, and is not exclusively characteristic of the affection known as *Pyorrhœa alveolaris*. Amœbæ are however met with in nearly all cases of the disease, and are found in all mouths, in

* C.R. Soc. Biol. Paris, lxxix. (1916) pp. 462–5.
† English Mechanic, June 23, 1916, pp. 431–2.
‡ Ann. Inst. Pasteur, xxx. (1916) pp. 286–97.

which the dental hygiene has been neglected, in the cheesy matter covering the teeth. In the case of well-cared-for mouths amœbæ are found in about 50 p.c. of the examinations, and generally speaking their presence coincides with a lowering of the normal resistance of the subject, and may therefore be considered as a predisposing cause of *Pyorrhœa*. Amœbæ are invariably absent in the various acute infections of the buccal cavity, while their presence is frequent in states of chronic infection. The rational hygiene of the buccal cavity constitutes the best means in completely excluding amœbæ or at least considerably reducing their numbers. The use of hydrochlorate of emetine, so highly spoken of by other observers, has, in the author's hands, been barren of results.

"**Aids to Bacteriology.**"*—This may be recommended to the student as a useful book of reference, both as regards technique and the theoretical aspects of the subject. The earlier chapters are devoted to a description of bacteriological apparatus, the preparation and use of nutrient media, and the technique of the preparation of material for microscopical examination. The nine following chapters contain descriptions of all the ordinary pathogenic bacteria in relation to their pathogenicity, cultural reactions, morphology, and methods of differentiation. The chapters are divided into the acid-fast organisms (*B. tuberculosis*, *B. lepra*, etc.); spore-bearing pathogenic organisms (*B. tetani*, *B. œdematis maligni*, *B. ærogenes capsulatis*, etc.): the colon-typhoid group (*B. coli*, *B. typhosus*, *B. paratyphosus A.* and *B.*, *B. dysenteriæ*, etc.): the *Bacillus diphtheriæ* group; the bacilli of the hæmorrhagic septicæmias (*B. pestis*, *B. pseudo-tuberculosis rodentium*, etc.); micro-organisms of suppuration and septic diseases (staphylococci, streptococci, pathogenic tetracocci, *B. pyocyaneus*, the gonococcus, the meningococcus, the acne bacillus, and *Diplococcus rheumaticus*). Chapter IX. discusses the pneumococcus and *Micrococcus melitensis* (no mention is made of *M. paramelitensis*), and Chapter XII. the influenza bacillus, Ducrey's and the Kocks-Weeks Bacillus, the bacillus of whooping-cough (Bordet and Gongou), the glanders bacillus, and the bacillus of epidemic abortion in cattle. Chapter XIII. is devoted to the cholera vibrio and cholera-like vibrios. The next six chapters cover a very wide range of subjects in a somewhat discursive manner, the trichomycetes, the blastomycetes, the hyphomycetes, pathogenic protozoa, enzymes, sulphur and iron bacteria, bacterial diseases of plants, diseases of questionable origin, and the filterable viruses being briefly surveyed. The last three chapters are devoted to the bacteriology of sewage, shellfish, soil, air and milk, the bacteriology of water, and the chemistry and application of disinfectants. The book concludes with a small appendix and a copious and useful index.

* Aids to Bacteriology, by C. G. Moor, M.A. (Cantab.) F.I.C., and William Partridge, F.I.C., 3rd ed.

## Metallography, etc.

**Reciprocal Solubility of Copper and Lead.***—By chemical and microscopical methods B. Bogitch has shown that a molten alloy of copper and lead separates into two layers when the copper content is between 34·5 and 87 p.c. and the temperature is between 940° and 975° C.

**Gold-cadmium Alloys.**†—P. Saldan includes a detailed description of the microstructure of numerous gold-cadmium alloys in an account of his investigation of this binary system. The alloys were examined as cast and also after annealing at 250° or 350° C. for ten days. Two compounds occur, AuCd and $AuCd_3$, which enter into solid solution with their components through a limited range.

**Persistent Brittleness in Steel.**‡—V. Bernard and A. Portevin have examined a piece of medium-carbon steel which had broken in use. Its brittleness was thought to be due to the overheating which was indicated by the coarse structure. Quenching from 850° C. followed by reheating to 700° C. replaced the coarse structure by a fine one, but impact tests showed that the brittleness had not been removed. A more careful microscopic examination then revealed the presence of indistinct narrow bands of ferrite forming a very coarse network. Lines of minute holes and inclusions in the middle of these ferrite bands formed surfaces of weakness, resulting in brittleness which could not be removed by any form of heat-treatment. The network of small holes and inclusions is regarded as the remains of an early and extremely coarse crystallization.

**Laminated Structure in Steel.**§—Y. A. Fechtchenko-Tchopovsky describes the laminated structures found in rolled steel such as rails and boiler-plates, and discusses their causes and the possibility of removal by heat-treatment. A markedly laminated structure found in a boiler-plate was partially or wholly removed by annealing followed by air-cooling, the effect being greater as the annealing temperature was higher. The laminated structure reappeared when the steel was again annealed and slowly cooled.

* Rev. Métallurgie, xii. (1915) pp. 655–6 (2 figs.).
† Int. Zeitschr. Metallographie, vii. (1914) pp. 3–34 (30 figs.).
‡ Rev. Métallurgie, xii. (1915) pp. 155–60 (7 figs.).
§ Rev. Soc. Russ. Métallurgie, ii. (1913) pp. 140–50 (20 figs.), through Rev. Métallurgie, xii. (1915) Extraits, pp. 269–73 (14 figs.).

# PROCEEDINGS OF THE SOCIETY.

## AN ORDINARY MEETING

OF THE SOCIETY WAS HELD AT NO. 20 HANOVER SQUARE, LONDON, ON WEDNESDAY, JUNE 21ST, 1916, MR. E. HERON-ALLEN, F.L.S., ETC., PRESIDENT, IN THE CHAIR.

**The List of Donations** received since the last Meeting was read as follows, and the thanks of the Society were accorded to the donors :—

| | From |
|---|---|
| Report of the British Association for 1915 .. | *Sir Frank Crisp.* |
| "La Science Française" (2 vols.) .. .. .. | *The Director of the Office "Nat. des Universités et Écoles franç."* |

**Mr. G. H. J. Rogers** demonstrated a home-made portable Microscope lamp, fashioned from an ordinary pocket electric lamp with the addition of a ground-glass screen.

The thanks of the Meeting were voted to Mr. Rogers for his interesting exhibit.

**Miss G. Lister, F.L.S.,** then gave a communication on the "Life-history of the Mycetozoa, with special reference to *Ceratiomyxa*," illustrated by lantern slides and copiously coloured drawings.

In the discussion which followed, **Mr. Hilton, Sir Edwin Ray Lankester, Professor Hickson,** and **Sir Henry Howarth** took part.

Miss Lister briefly replied to the points raised in the discussion, at the conclusion of which a very cordial vote of thanks was passed to Miss Lister for her interesting communication and exhibition, to Messrs. Hilton and Huish for their exhibits, and to Mr. Angus for providing a goodly supply of Microscopes.

**The President** drew the attention of the Fellows to the loss the Society had sustained by the death of two prominent Fellows—Mr. Richard Thomas Lewis, who had been a Member since 1866 ; and Mr. Frederick Enock, well-known for his interesting and popular expositions of the life-histories of various insects.

It was announced that the rooms of the Society would be closed from Wednesday, August 16, to Wednesday, September 20.

**The following Specimens were exhibited** .—

Mr. Sydney C. Akehurst, F.R.M.S. :—Germinating spores of *Reticularia lycoperdon*.

Mr. A. E. Hilton :—Creeping plasmodium of *Badhamia utricularis*, showing the reversing currents.

Mr. C. H. Huish, F.R.M.S. :—Collection of Mycetozoa, embracing representatives of thirty-four genera.

Miss G. Lister, F.L.S. :—

1. *Amaurochæte fuliginosa* (Sow.) Macbride. Swarm-cells dividing; their nuclei undergoing mitosis.
2. *Badhamia utricularis* Berk. Plasmodium showing resting nuclei ("diploid," with sixteen chromosomes).
3. Ditto. Plasmodium with nuclei dividing by mitosis. Prepared by J. J. Lister.
4. Ditto. Part of section of young sporangium showing highly vacuolated protoplasm, and nuclei undergoing reduction division prior to spore-formation.
5. Ditto. Spore mother-cells from a maturing sporangium dividing into spores; the daughter nuclei are "haploid" and have eight chromosomes.

5a. *Trichia decipiens*. Section of young sporangium with dividing nuclei. Prepared by J. J. Lister.

6. *Ceratiomyxa fruticulosa*. Mature sporophores.
7. Ditto. Expanding stage of very young sporophore showing a solid network of plasmodium; nuclei in resting stage.
8. Ditto. "Expansion stage" passing into "network stage"; the plasmodium is almost entirely concentrated on the surface of the young sporophore in a thick layer.
9. Ditto. "Network stage": the plasmodium spreads over the surface of the sporophore in a thin close net: it is at this stage that the nuclei undergo reduction division.
10. Ditto. "Network stage" passing into the "Mosaic stage" in which the spore mother-cells are formed.
11. Ditto. Cells passing from "Mosaic stage" to that of stalked spores.
12. Ditto. Transverse section of a group of young anastomosing sporophores, showing the young peg-top shaped spores, each with a nucleus; the gelatinous substance of the sporophores strongly stained Prepared by J. J. Lister.
13. *Barbeyella minutissima* Meylan. Sporangium. This minute species has hitherto been found only in the Jura Mountains by M. Ch. Meylan.
14. *Clastoderma debaryanum* Blytt. Sporangium. This minute and widely distributed species has not yet been recorded from Britain. It appears to be nearly related to *Barbeyella*.
15. *Echinostelium minutum* de Barry. Sporangium. This very minute species has been found three times in Britain, twice by Miss Lorrain-Smith and once by the Rev. W. Cray. It is closely related to *Clastoderma*.

Drawings were shown from preparations made by Dr. Jahn, of the Berlin University, showing dividing nuclei in the "network stage."

---

**New Fellow.**—Mr. E. Marshall Hall, K.C., M.P., was elected an Ordinary Fellow of the Society.

# JOURNAL

OF THE

# ROYAL MICROSCOPICAL SOCIETY.

OCTOBER, 1916.


## TRANSACTIONS OF THE SOCIETY.

### XIV.—*Originative Factors in Evolution.*


By Professor J. Arthur Thomson, M.A. LL.D.



*Read March* 15, 1916.


§ 1. A good many years ago there was born in an apparently normal North of Scotland family a child who grew up to be a wise and well-proportioned dwarf. He married and had children—a certain number of whom were dwarfs. The peculiarity re-appeared in grandchildren and great-grandchildren, and one of the fourth generation is now at the head of a successful business—a wise and well-proportioned dwarf. The question before us, discussible if not answerable, is, What conditioned the dwarf? This is one of the fundamental problems in Biology—the origin of the distinctively new. Whether it be a clever dwarf, a mathematical genius, a 10-foot tailed cock, a copper-beech, a greater celandine with laciniate leaves, the general problem is the same, the old problem of new departures. *What are the originative factors in organic evolution?*

§ 2. A problem so difficult demands cautious handling, and an elementary introduction requires no apology. The first question is as to the nature of the novelties that actually occur, and the sound procedure is to take stock of all observed peculiarities or differences marking off individual organisms of the same kind. These "observed differences" must be measured and registered without theory or prejudice. We compare the colour of the trout we catch from different streams, the various numerical relations of radial canals and sense-organs in a thousand jellyfishes, the

plumage in a score of ruffs, the number of vertebræ in a hundred fishes of the same species, and so on. We register the observed differences.

It soon becomes plain, however, that analysis of our data is necessary, if we are to avoid fallacy. We must try to sift out peculiarities which are associated with age and with sex, or are directly due to peculiarities of nurture. It is obvious that immature herrings must be compared with immature, and that we must not mix up the ruffs and the reeves, drones and worker-bees. More difficult, however, is it to separate off those peculiarities which can be experimentally shown to be individually acquired modifications, directly due to peculiarities in nurture (whether nutritional, environmental, or functional). Many crabs are profoundly changed by being parasitized by Sacculina and other Rhizocephala, and a conclusion as to variability in crabs is vitiated by mixing up the parasitized with the normal. An organism dwarfed by lack of food or lack of space for exercise, such as the freshwater snails studied by Semper and De Varigny, is in a different category from a normal dwarf appearing in a family with no dwarfs in its recent lineage. The much cut-up leaves of the freshwater buttercup in the swiftly flowing water, one of the examples Lamarck gave of the direct results of environmental influence, are not to be placed beside the laciniate leaves of the variety of *Chelidonium majus*, which cropped up a long time ago in an apothecary's garden in Heidelberg, and has been breeding true ever since. These directly induced, exogenous modifications Darwin called "definite variations"; they are badly called "individually acquired characters"; they are best called "somatic modifications." As there is not at present any convincing proof of the transmissibility of these somatic modifications as such or in any representative degree, they must be left, in the first instance, out of account in our inquiry into the origin of the distinctively new. They may be of great import for the individual, but if they are not transmitted they cannot be of more than indirect importance to the race. It does not follow, however, that a changeful environment may not be an originative factor in evolution.

When we subtract from the total of observed differences those that can be shown to be modifications, when we also eliminate the peculiarities associated with differences of age and sex, the remainder are for the most part (in proportion to the success of our subtraction) what are called variations—inborn not acquired, intrinsic not extrinsic, blastogenic not somatogenic, endogenous not exogenous, arising from the constitution of the germ-cell not impressed from without, expressions not dints. Some of them at least are very transmissible, and it may be said that these constitute the raw materials of evolution.

§ 3. The next step is to inquire whether all the inborn varia-

tions are on the same platform, and here we may go back to Darwin's distinction between "single variations" and "individual variations," though the terms are not felicitous. By "single variations" Darwin meant sports, abrupt changes of notable amount, such as that which gave rise to the copper-beech in the seventeenth century, or to hornless cattle, or to short-legged sheep, or to Angora rabbits, or to fantail pigeons. They correspond to Galton's "transilient variations," to Bateson's "discontinuous variations," to De Vries's "mutations," and the last name should be kept for them. By "individual variations" Darwin meant the minute, ubiquitous peculiarities which distinguish child from parent, brother from brother, cousin from cousin. Though he was much interested in brusque "sports," it was to minute fluctuations (or individual variations) that he mainly looked for supplying the raw materials of new species. "The more I work," he said, "the more I feel convinced it is by the accumulation of such extremely slight variations that new species arise." Some authors have tried to identify Darwin's slight individual variations or fluctuations with the somatic modifications already referred to, but this is not what Darwin meant, as is plain from such a sentence as this: "If, as I must think, external conditions produce little direct effect, what the devil determines each particular variation." Moreover, fluctuations or minute variations often arise among animals whose conditions of life appear to be quite uniform. On the other hand, what Johanssen calls fluctuations in "pure lines" of beans are probably slight modifications due to differences in nurture. Little is known in regard to the transmissibility of fluctuations or minute variations in the Darwinian sense, but the recent work of Castle, for instance, shows that it is in some cases demonstrable.

It is a curious fact that one of the reasons why Darwin attached little importance to sports or mutations was his belief that they would be swamped in inter-crossing. In reality they are highly transmissible. When they come they often come to stay, unless they are pathological on the one hand, or too superlative, like geniuses, on the other. What is desirable at present is more evidence of the transmissibility of the small fluctuations of germinal origin, a transmissibility which Darwin assumed without question.

§ 4. Turning our attention now to the problem of the origin of inborn variations, we may perhaps usefully distinguish two levels of difficulty. There are variations and variations. There are some novelties that imply just a little more or a little less of some quality—a slightly longer tail, a slightly denser blackness, a slightly stronger flight-muscle, a slightly weaker eye; some that involve a disappearance of an entire character, such as hair or horns, tail or pigment; some that may be described as obvious

re-arrangements of the characters displayed by the ancestry, as we see in a piebald pony or in a hybrid cockatoo. Now, it does not seem very difficult to imagine the origin of this kind of quantitative variation. Without pinning our faith as yet to any very detailed view of the material basis of inheritance, we may regard it as certain that the chromosomes play an exceedingly important part as vehicles of the heritable qualities. We may compare them to a microscopic pack of cards, and we know that they are sometimes visibly different from one another in the same germ-cells, and that there is an extraordinarily elaborate shuffling of the cards before development begins. In the reduction-process involved in the maturation of the egg-cell, half of the ovum's pack is thrown away, usually in the first polar body, and comes to nothing. In the maturation of the spermatozoa there is also a halving of the pack, but all the reduced units are in this case functional. In fertilization the two half-packs come together in intimate and orderly union, though without fusion of chromosomes, forming the zygote-nucleus. The opportunities for permutations and combinations of hereditary items, and for the dropping out of one or more altogether, are obvious. Thus the origin of variations of a quantitative sort does not seem beyond our power of conception, except in the sense that we do not in any way understand cell-division, whether meiotic or equational.

§ 5. A separate consideration may be given to fertilization as a source of variation, a view prominent at one stage in the development of Weismann's theories. For a time he was inclined to attach great importance to the mingling (or amphimixis) of two sets of hereditary qualities as a possible source of novelties, but he afterwards attached more importance to the influence that somatic fluctuations in nutrition might have in inducing changes in the germ-plasm or in inducing struggle among the analogous hereditary items. In recent years the botanist Lotsy has been a thorough-going champion of the variational significance of fertilization, and has gone the length of maintaining that all variation is due to crossing. That this is a very extreme view is shown by the occurrence of variations in parthenogenetic lineages, but there is ample experimental evidence that novelties may be induced by crossing. This is not surprising when we remember that two very complex systems of dual origin become in fertilization a unity that goes on in most cases to develop into a harmonious life.

§ 6. The problem before which we are baffled is the origin of the distinctively new, where the novelty is qualitative not quantitative. Some would refuse to admit this distinction, and perhaps they are pedantically right: the distinction is one of common sense. There is many a grade between those who find their fingers indispensable in simple computations and the calculating boy who can tell us in a few seconds the cube root of 17,073,512,

yet cannot explain how he knows; but there seems good sense in recognizing the latter as a qualitative change. So with the mathematical genius, the musical genius, the artistic genius; and there is not any reason to believe that man is the only species that produces geniuses. The evidence of their occurrence elsewhere is in the rapidly growing records of mutations of large amount. There is a mutation-theory, but is there any theory of mutations?

On the dark problem of the origin of the distinctively new some beams of light have been shed. (*a*) First, there are facts suggesting that deeply saturating environmental influences may act as variational stimuli on the germ-cells and provoke change. MacDougal injected solutions of sugar and compounds of calcium, potassium, and zinc into the developing ovaries of one of the Evening Primroses, and got out of several hundreds of seeds sixteen individuals notably atypical, which bred true to the second and third generation. There were not only losses and augmentations, there were distinct novelties which maintained their distinctness when crossed with the parental strains. It should be noted that what MacDougal injected was not very much out of the way, and might be paralleled by natural changes in the chemical composition of the sap of the plant.

Pointing in the same direction are the well-known experiments of Tower, who subjected potato-beetles to unusual conditions of temperature and humidity when the male or female reproductive organs were at a certain stage of development. The results were strangely lacking in uniformity, but some of the offspring showed striking and persistent changes, not only in colour and markings, but also in some details of structure. Tower's work has met with some adverse criticism, but, taken along with similar experiments, it suggests that we must not overlook the possibility of deeply-saturating environmental influences acting as variational stimuli—affecting not the body of the parent, but the germ-cells within. Here should be included Weismann's view that fluctuations in bodily nutrition may prompt the germ-plasm to vary.

(*b*) Some of the researches of recent years, such as those of Gates on Evening Primroses (Œnothera) and of Morgan on the Pomace-fly (Drosophila), have focused attention on the chromosomes. It is a distinct step to know that certain peculiarities of particular mutants are associated with visible alterations in the chromosomes of the fertilized egg-cell. It is very interesting to know that while the fundamental number of chromosomes for the genus Œnothera is fourteen, this has become fifteen in *lata* and *semilata*, twenty-one in *semigigas*, twenty-eight in *gigas*, and so on. These are the numbers observed in the fertilized egg-shell and in every element throughout the plant.

In this connexion a reference may be made to what obtains in

Man. Competent observers have stated that the cells of the male negro have twenty-two chromosomes, and it is probable that the negress has twenty-four, at least in some cases. Now, in the white man and woman the enumerations of Winiwarter and others have usually been forty-seven and forty-eight, though sometimes thirty-two or thereabouts. It seems curiously difficult to reach certainty in regard to this simple point, but there is no harm in asking, as Gates does, whether the white man may not have originated from a black race by a "tetraploid mutation and its consequences."

The nuclear changes studied in Œnothera in their association with particular mutations are not restricted to changes in the *number* of chromosomes; they may concern their shape, size, and structure. What has been gained is a demonstration that in some cases bodily peculiarities of mutants are correlated with visible changes in germinal organization.

Now, one is not unaware that this is just telescoping-down the Proteus of the full-grown organism into the germ-cell phase of its being, and that a recognition of germinal disturbances does not tell us what conditions them. As Bateson has often said, we find ourselves confronted with the oppressive difficulty of cell-division and irregularities in its procedure. Yet there is an enlightening gleam in the proof that somatic mutations are correlated with antecedent germinal disturbances, for we know that abnormal cell-divisions occur in various conditions in nature, and we have already referred to the opportunities for re-arrangements that occur in the early history and maturation of the germ-cells. Is there any further light?

(*c*) We must remember that chromosomes are living units in a complex environment, and just as Bacteria sometimes change suddenly in their physiological properties, so chrosomomes may vary in their stereochemic architecture or in functional powers. Moreover, it is not fanciful to suppose that these vital units, which have great persistence of "individuality," may exhibit age-changes or periodic re-organization processes.

Here may be profitably considered the recent work on the Slipper-Animalcule (*Paramecium aurelia*) by Woodruff and Erdmann. Woodruff has kept a pure line of this Ciliate healthy for over seven years, through more than 4500 generations. As is usual in a pure line all descended from one there was no conjugation. On an average of once a month, however, a remarkable regulatory process occurs, which the authors call endomixis, which secures the indefinite life of the race. Nuclear changes, comparable to those that precede conjugation in normal wild conditions, set in: the old nuclear material, both macronuclear and micronuclear, is disintegrated and re-organized; but there is no formation of stationary and migratory micronuclei as there is before

conjugation. For conjugation is not going to occur; something that takes its place is occurring—*endomixis*. Now, it seems probable that such a periodic reoganization of nuclear material will afford opportunity for plasmic rearrangement, and that may imply the origin of variations even within a pure line. Jennings has found in pure lines of non-conjugating Paramecium evidence of variations about the mean. These might be due to rearrangements effected in endomixis. It is conceivable, as Woodward and Erdmann point out, that "heritable" variations may result from some rare recombinations in endomixis.

This Paramecium is a very complicated organism, as Clifford Dobell has vividly emphasized, on the non-cellular line of evolution, and we find it in certain conditions exhibiting a monthly reorganization as part of its life-cycle. Is it not possible that some similar reorganization may normally occur in Metazoa at the origin of each individual life, and that, if it does, there is no need to look about for any special cause? It is all in the day's work; it is part of the programme of the essentially regulative life-cycle. We may recall, too, that variation may occur in parthenogenetic or aspermic development, as well as in the ordinary process.

We are not seeking to "explain" variations by verbal inventions. Our argument is quite clear: Certain mutations in organisms are preceded by germinal disturbances; perhaps these germinal disturbances are comparable to endomixis in Paramecium. It is always a step towards understanding to put one obscure process alongside of another which is similar to it and which may be more amenable to experimental treatment. Therefore we suggest that endomixis may be profitably considered along with the problem of the origin of variations.

(*d*) Another gleam of light may possibly be found in Child's long-continued study of processes of senescence and rejuvenescence —a study recently presented in its entirety in a remarkable volume, "Senescence and Rejuvenescence" (1915). Child finds that when a fragment of a Planarian regrows a whole, there is a rejuvenescence during the re-constitution; the rate of metabolism is high, and the resistance-power is great. The metabolism may be measured by Tashiro's "biometer," an extraordinarily delicate register of the $CO_2$ output, or more indirectly by the degree of susceptibility and resistance to cyanides and the like. Judged by these tests, the regenerating piece of Planarian is younger than it was when it formed part of the parent. It literally renews its youth. Similarly, when a Planarian or a Hydroid multiplies asexually, the separated-off piece shows marked rejuvenescence, as revealed by the two tests named.

Child's thesis is this: As an organism differentiates, it ages, for the accumulation of relatively inactive constituents in the colloidal cytoplasmic substratum necessarily involves a decrease in the

metabolic rate; but there are counteractive processes of reduction, removal, and de-differentiation, when the metabolic stream erodes its bed instead of depositing materials. These are marked by acceleration in metabolic rate, and constitute rejuvenescence. "It is certain," Child says, "that the new individuals which arise by division or budding from other individuals, or from experimentally isolated pieces, are to some extent physiologically younger than the parent individual from which they arose."

The idea of a see-saw between processes of senescence and rejuvenescence finds many illustrations among the lower animals; but what of higher levels? Child finds some interesting evidence that the early developmental stages of a number of animal types, before specialization of cells sets in, are conspicuously young in the physiological sense. The germ-cells themselves are very stable condensations of hereditary items, but in the early development there is a time of reconstitution, of de-differentiation, of relaxation. If there is any soundness in this view, in support of which data are of course submitted, we may perhaps recognize another opportunity for variation, namely, in the very young embryo, where the alleged rejuvenescence may include possibilities of rearrangement and, as it were, re-tuning.

§ 7. At this stage we must refer to Professor Bateson's interesting suggestion in regard to the possibilities of gain by loss, of the emergence of mutations by the removal of inhibiting factors. There are a few people who believe that reptiles came from birds, not birds from reptiles, and fishes from amphibians, not amphibians from fishes, but this topsy-turvy view of evolution is not confirmed by the rock-record. It is quite possible, however, that the first organisms were not the "simple drops of living matter" that people talk about too easily; it is possible that they were only apparently simple (like some great geniuses), but in reality rich in complexities which it has taken many millions of years to unravel. In his Presidential Address to the British Association, meeting in Australia in 1914, Professor Bateson said that "we must begin seriously to consider whether the course of Evolution can at all reasonably be represented as an unpacking of an original complex which contained within itself the whole range of diversity which living things present. . . . As we have got to recognize that there has been an Evolution, that somehow or other the forms of life have arisen from fewer forms, we may as well see whether we are limited to the old view that evolutionary process is from the simple to the complex, and whether after all it is conceivable that the process was the other way about. . . . At first it may seem rank absurdity to suppose that the primordial form or forms of protoplasm could have contained complexity enough to produce the divers types of life. But is it easier to imagine that these powers could have been conveyed by extrinsic

additions? . . ." Mr. Bateson does not mean, of course, that the lower animals were evolved from the higher, or any nonsense of that sort. He asks us, however, not to think of the primordial forms of life as necessarily very simple. We are to think of them as richly endowed with initiatives and potentialities. He is particularly inclined to this view because his extraordinarily fine experimental work has led him to conclude that most of the novelties that appear nowadays in garden and breeding-pen are due to the removal of hindrances that suppress or mask underlying qualities, or to the unpacking of a crowded treasure-box and placing assorted jewels in special caskets. Everyone knows of the large number of beautifully coloured Sweet Peas that have been put on the market in recent years. But few people realize that these have been derived from one wild Pea, and not by adding on new excellences, but by successive removals—by unpacking the treasure-box. Mr. Bateson appears to believe that the reason why we are not all geniuses is not that we have not got it in us, but that we cannot get it out—of prison. When the genius emerges it is not a new achievement that has been made, it is that certain hindrances or inhibitors have been removed. So the process of evolution has been a succession of liberations, rather than of achievements, gains by loss.

In this interesting theory we recognize two truths, first, that when genuine living creatures did first appear as going concerns, they had within them the secret of a possible glorious future ("ce n'est que le premier pas que coûte"); and, second, that many apparently novel acquisitions are due to the removal of some inhibitor, or some mask, or some complexity in the inheritance. We are unwilling, however, to accept Professor Bateson's picture as a complete one, and that for several reasons. 1. The first is, that it makes the origin and nature of the primordial organisms too utterly miraculous if we suppose them to have had such a rich stock of initiatives and implications. 2. It seems to lead to a too mechanical picture of evolution, as if it were just an age-long unrolling of a stupendous gramophone record. Time is required for unrolling the record, but time does not count for the gramophone as it counts for the organism, *which trades with it.* Space is required for unrolling the record, but space does not count for the gramophone as it counts for the organism, *which traffics with its environment.* 3. Given an artistic genius, we may assert that all that he did in the last forty years of his life was in him when he was twenty-one. But is this necessarily an accurate statement? His achievements at thirty may be the product of his hereditary nature admittedly well-expressed at his coming of age, but also of what he has made of his life and his chances, and of what society has made of him. The organism works on a compound-interest principle; especially in its mental aspect

it is made as well as born. And what is true of an explicit individual, that he makes experiments in self-expression, may be true, for aught we know, of those implicit, telescoped-down individualities which we call germ-cells. In any case, we see no reason to part with the idea of the full-grown organism as an agent that shares in its own evolution.

§ 8. The tendency of modern research has been to lay emphasis on the idea of hereditary particulateness, that the characteristics of organisms are made up of elementary units, without intergrades, as sharply separated from one another as the chemical elements. This is the idea of "unit characters," independently heritable and independently variable. It is very striking that a trivial feature in the hands*—a reduction of the index and middle finger (in spite of the presence of a little extra triangular bone at their bases) and a consequent projection of the ring-finger should behave as a Mendelian character for at least four generations, and be found in fifteen out of thirty-six descendants of the family investigated. There is indirect evidence that particular unit characters are represented by particular particles (factors, determinants, or genes) in the germ-plasm, or perhaps by ultra-microscopic differences of architecture, and the idea works well, like the atomic theory in chemistry. But it has its limitations, and it must not be pressed so hard that we lose sight of the unity of the organism even in the germ-cell phase of its being, and of the fruitful conception of correlated variations. An exaggeration of the idea of particulateness leads to a view which is too mechanical to fit living creatures, as if the organism evolved like a machine perfected piecemeal by the adding on of many little patents independent of each other. A reaction may be seen in the recent book by Professor T. H. Morgan and others on "The Mechanism of Mendelian Inheritance" (1915), where it is insisted that the so-called unit character is only the most obvious or most significant product of the postulated "factor," that the effects of a "factor" may be far-reaching and manifold, and that a single character may depend on many "factors" which interact. "Cases of interaction of factors, in which the effect of one factor is altered by the action of another factor, are very numerous." "The expression of a factor-difference may not be limited to one region, but may produce a different effect in different regions."

There is much to suggest that we should do well to appreciate afresh the idea which Darwin and Sir Ray Lankester have emphasized of the "correlation of variations," that one change—as we see, for instance, in disease—may have manifold expressions or outcrops in different parts of the body, that the organism may change as a unity in many parts at once. It is not difficult to

* H. Drinkwater, Journ. Anat. Physiol., l. (1916) pp. 177–86 (14 figs.).

suppose that a change in the rate of a particular kind of metabolism may reverberate through the body. As Mr. J. T. Cunningham and Professor Dendy have pointed out, an augmentation or a diminution of certain internal secretions or hormones might have multitudinous transforming effects.

§ 9. The growing body of evidence that mutations or brusque variations are not infrequent in their occurrence, and that if they come they often come to stay, lessens the element of the casual in organic evolution. It also lessens the need for over-burdening the rôle of natural selection, especially as an accumulator of minute increments or decrements. But along with this there should be considered the idea that variations are limited in some measure by what has gone before. At the beginning of each individual life there is the fertilized ovum, a viable unity. If a variation occur it is not like to grip unless it be congruent with the germinal organization already established; it must harmonize, just as an addition to a crystal must, but within a wider range. The character of the building that has been erected determines in some measure the nature of an addition to it. The idea of architecture is, of course, only one aspect; the novelty must be congruent with the previously established reaction-system and specific metabolism. Out of the same spring we do not get sweet water and bitter. Thus the element of the fortuitous shrinks still farther. It is interesting to find that monsters sometimes result from infelicitous crossings, but perhaps a greater interest attaches to the fact that monsters are so rare in nature, not only in survival, but in occurrence.

An illustration of the limiting of changes by pre-existing organization may be found in a recent paper * by Professor S. J. Hickson, in which he notes that meristic variability in important organs is much greater in radially symmetrical forms than in bilaterally symmetrical forms where a balance must be kept. In reference to the Pennatulacea he shows that variable or plastic characters may become less variable or plastic as a transition is made from radial to bilateral symmetry, and points out that increasing rigidity of certain characters leads in some cases to the differentiation of the discontinuous groups which are recognized as species. What we would suggest is carrying this idea from the fully-formed organism to the germ-cell organism, from the phenotype to the genotype, and considering substantive as well as meristic variations.

§ 10. Let us sum up. Germinal disturbances or re-arrangements occur, and these may find expression in development as variations or mutations of the organism. The question is, What brings about the re-arrangements? a question to be asked in the light of the

* Mem. and Proc. Manchester Lit. and Phil. Soc., lx. (1916) pp. 1–15.

fact that, frequent as variations are, hereditary constancy, or inertia, or persistence of specificity is even more marked. The following suggestions are before us. That germinal disturbances come about in response to subtle environmental stimuli of a novel kind penetrating in from without and affecting the chromosomes, or perhaps the "mysterious karyolymph or gel which forms the groundwork of the nucleus." Along with definable changes in the external environment may be included changes in the somatic fluids which might affect the nutritive or other metabolism of the germ-cells. That in the divisions of the germ-cells before fertilization, where there has to be a partition of a complex cytoplasmic and chromosomic cargo between two vessels, losses and augmentations and inequalities may be expected in the transhipment. That in fertilization with its intimate and orderly union of paternal and maternal contributions (amphimixis) there may be opportunity for new permutations and combinations, the result normally being a viable unity of dual origin. That there may be growth-changes, or regulative re-organization processes, or rejuvenescences in the germ-cells in the course of their history; and it is possible that there may be something in Weismann's hypothesis of intra-germinal struggle.

§ 11. We are thus aware of certain originative factors in evolution, which admit of experimental testing, and we should not lose sight of any of them. Each must be pushed as far as it will go. Recognizing this, some will insist that there is no more to be said, but much to be done. We venture to doubt, however, whether this is not making a tyranny of scientific method (which, after all, is very selective and partial), and giving up the right of speculative adventure. As the great Russian embryologist von Baer said: there is observation, but there is also reflection.

Those who have devoted much attention to the occurrence of variations—we think, for instance, of Darwin and Bateson—have given emphatic expression to their sense of the difficulty of accounting for the origin of the new. The fountain of change, whence are its well-springs? But we also notice that some of those who have given much of their life to the study of the phenomena of variation occasionally lapse from the stern path of science, and in face of the difficulty of the problem ask themselves if they are allowing enough for the fact that the organism is alive. Thus we would quote from the recent work of Dr. R. R. Gates, on "The Mutation Factor in Evolution," this interesting sentence: "Just as an Alpine climber dangling over a chasm may, by changing his hold, swing himself on to a shelf from which he can make a fresh start in some other direction, so we may think of the organism trying many unconscious experiments in its offspring, some of which are hurled by the gravitational effect of natural selection

into the abyss of extinction, while others with a more fortunate turn rest on a ledge of safety whence new essays of variability begin." But Dr. Gates Mutationist soon takes the place of Dr. Gates Psycho-biologist. After this one exciting glimpse of the organism as climber, we are hurried back to the chemical and physical complexity of the protoplasm and its unique irritability and retentiveness. But we are disposed to linger over the idea of the organism as climber, and the organism here means the genotype, not the phenotype. It is not suggested that the germ-cell is dominated by any purpose of getting to the top of anything, or of circumventing any particular difficulty, but rather that there is inseparable from it a restless experimenting in self-expression, bearing the same relation to the insurgent self-assertiveness of the full-grown creature that the tentatives of dreamland bear to the achievements of open-eyed and deliberate endeavour.

The position we are suggesting is that the larger mutations—the big novelties—are expressions of the whole organism in its germ-cell phase of being, comparable to experiments in practical life, solutions of problems in intellectual life, or creations in artistic life. These are accomplished, everyone knows, by molecular activities in the brain and body, but they are not intelligibly thought of unless we conceive of the organism as a psycho-physical individuality, a mind-body or body-mind, as we will. Similarly it may be that our conception of germinal variability is falsely abstract unless we recognize that germ-cells are living individualities of great complexity telescoped-down into a one-celled phase of being, and that they too make essays in self-expression.

Perhaps we mislead ourselves by repeating too often, in our elementary teaching for instance, the commonplace that the Metazoon begins its life as a single cell. It is true enough in a way, but certainly not the whole truth. It is no commonplace cell, the gamete. It is an organism *in potentiâ*. Within it, in some manner that we cannot begin to image, though we crowd it with factors and genes (the modern successors of Darwin's gemmules and Weismann's determinants), there lies a complex inheritance, unified afresh at the start of each new generation. If an Amœba has a behaviour, as Jennings seems to have proved, may not the much more richly endowed germ-cell of a fruit-fly be allowed the capacity of putting its house in order? If the Foraminifer *Technitella thompsoni* picks up and chooses the materials of its encasement and builds this with what looks like a dawning art, may not the ovum of an Evening Primrose be allowed some freedom of internal architecture? Germ-cells are not corpuscles of undifferentiated protoplasm. They are individualities that live and multiply, that struggle and combine. They are repositories of multiplicate inheritances borne by strangely persistent smaller

living units, the chromosomes, which adjust themselves in the most momentous of organic compromises. Is it fanciful to suppose that these gametes—neither simple cells nor portmanteaus of hereditary factors, but unified individualities — experiment internally, not fortuitously but artistically, not at random nor yet inexorably, not purposefully but perhaps purposively, and that they are as truly body-minds or mind-bodies as Amœbæ or as Men ?

# SUMMARY OF CURRENT RESEARCHES

RELATING TO

# ZOOLOGY AND BOTANY

(PRINCIPALLY INVERTEBRATA AND CRYPTOGAMIA),

# MICROSCOPY, ETC.*

## ZOOLOGY.

### VERTEBRATA.

#### *a.* Embryology.†

**Process of Ovulation.**‡—S. S. Schochet has studied this in the sow. It is generally concluded that pressure atrophy of the ovarian stroma is the chief means by which the extrusion of the ovum becomes possible. During the growth and maturation of the ovum, the cells of the Graafian follicle, after increasing greatly in number, begin to disintegrate and liquefy. From then onward, due it is thought to the different chemical composition of the fluid or of the general content of the follicle, an endosmosis seems to be induced which increases the liquor folliculi to an amount far greater than can be regarded as consequent on the liquefaction of the follicular cells. The follicle distends and, following the direction of least resistance, forms a bulging on the surface of the ovary, dispersing the ovarian stroma, thinning its tunica albuginea and the overlying epithelium, and results in a compression of the blood capillaries intervening between it and the surface of the ovary. Clark has shown that the capillaries in the summit of the bulging are practically obliterated by the pressure. It is supposed that nourishment is thus cut off from the ovarian stroma under compression, and that the stroma atrophies till its resistance is less than the pressure exerted by the distending follicle. The content of the follicle then bursts into the body cavity. The liquefying of the follicular cells having continued till the ovum is free within the follicle, the ovum is extruded into the body cavity with

* The Society are not intended to be denoted by the editorial "we," and they do not hold themselves responsible for the views of the authors of the papers noted, nor for any claim to novelty or otherwise made by them. The object of this part of the Journal is to present a summary of the papers *as actually published*, and to describe and illustrate Instruments, Apparatus, etc., which are either new or have not been previously described in this country.

† This section includes not only papers relating to Embryology properly so called, but also those dealing with Evolution, Development, Reproduction, and allied subjects.

‡ Anat. Record, x. (1916) pp. 447–57.

the discharge of the liquor folliculi. But Schochet has been able to supplement this view of ovulation by evidence showing that the rupture of the Graafian follicle is due in part to the digestion of the theca folliculi by a proteolytic ferment in the liquor folliculi.

**Implantation and Early Segmentation of Opossum Ovum.***—Charles H. Spurgeon and Ralph J. Brooks have studied this in *Didelphys virginiana*. The ovum proper makes up a relatively small amount of the complete egg. Its cytoplasm is coarse, granular, and much vacuolated. The egg envelopes are divided into two or more distinct areas. The central one which immediately surrounds the egg is composed of many concentric, coarse, reticular layers. The peripheral area is finely reticular, and the layers are not well defined.

Selenka stated that the ovum of the opossum is intermediate in type between the meroblastic and holoblastic egg. The authors point out that it is difficult to understand this statement unless it refers to the yolk extrusions and the egg envelopes. There are extrusions of yolk given off before the egg begins to segment. The egg proper is holoblastic. The egg envelopes probably correspond to the accessory envelopes of the hen's egg. The extrusions of yolk or cytoplasm lie around the blastomeres: they do not take any nuclear stain; they are probably re-absorbed as food.

The ovum shows marked polarity. The first and second polar bodies are sometimes evident. The blastomeres do not adhere closely. There is much mortality in the developing ova, and there are always more ova in the uteri than there are embryos in the marsupium.

**Influence of Pituitary feeding on Growth and Sexual Development.**†—Emil Goetsch has experimented with rats. Dried pituitary extract from both anterior and posterior lobes of the gland hastens the growth and development of the ovaries and testes. It also increases the functional activity. Feeding with anterior lobe extract causes increased weight and greater and more vigorous body-growth and development. Posterior lobe extract, however, has a retarding influence. Ovarian extract (corpus luteum) has a stimulating influence upon the female sexual development, but retards that of the male.

**Inter-relations of Mesonephros and other Organs.**‡—J. L. Bremer divides Mammalian embryos into two groups; those which retain functional Wolffian bodies (acting as glands of urinary excretion) until the kidneys are sufficiently developed to excrete urine, as is the case in birds and reptiles, and those in which the Wolffian bodies degenerate before the kidneys reach functioning capacity. The first group includes the pig, sheep, and cat; the second, the rabbit, guinea-pig, man and rat. Within each of these groups individual animals show great differences in the size and presumable excretory capacity of the Wolffian body or mesonephros, without regard to its duration.

* Anat. Record, x. (1916) pp. 385–95 (15 figs.).
† Bull. Johns Hopkins Hospital, xxvii. (1916) pp. 29–50 (13 figs.).
‡ Amer. Journ. Anat., xix. (1916) pp. 179–209 (2 pls.).

The allantois is the receptacle for the urine formed within the body of the embryo. It is present as a reservoir only in those animals which have an embryonic excretion. Its size varies with the size of the Wolffian bodies and with their duration. The urethral opening, though present, is not normally used for the passage of fœtal urine.

In those animals without the possibility of a continuous urinary excretion within the embryo, i.e. with an early degeneration of the Wolffian body, the placenta is provided with an apparatus similar to that found in the glomeruli of the Wolffian body or the kidney, thin plates of epithelium overlying the fœtal capillaries. These appear in the placenta at about the time when the Wolffian body begins to degenerate, or, in the case of the rat, which never develops mesonephric glomeruli, at about the time of the normal development of the glomeruli in other embryos. These plates continue and increase in number till birth. They are apparently of greater extent in animals whose embryos are provided with large Wolffian bodies. In the placenta of animals with a continuous embryonic urinary excretion, similar plates are not found. It appears that embryonic and fœtal urinary excretion takes place wholly through the placenta in the rat; that it takes place first through the Wolffian body, and later through the placenta in the rabbit, guinea-pig, and man; and that it never takes place through the placenta in the pig, sheep, or cat.

**Yolk-Sac of Pig Embryo.***—H. E. Jordan gives an account of the minute structure of the yolk-sac, with its endoderm, mesothelium, mesenchyme, endothelium and blood-cells. The latter include (1) the hæmoblasts or blood mother-cells; (2) the erythroblasts; (3) the normoblasts, which along with (2) form the erythrocytes; and (4) the giant cells, both megakaryocytes and polykaryocytes.

The yolk-sac endoderm is of course continuous with the epithelial lining of the gut, and the cells show numerous basal filaments, like mitochondria, which probably have secretory significance. In ancestors with yolk-laden eggs the endodermal cells undoubtedly had the function primarily of elaborating a digestive fluid for the liquefaction and assimilation of the yolk. In yolkless umbilical vesicles, the endoderm apparently still develops and differentiates in accord with an "ancestral memory," though it can perform no true digestive function. The umbilical vesicle has, however, taken on a secondary function as an early, perhaps original, centre of hæmopoiesis.

The angioblast or original primordium of the vascular tissue in the yolk-sac has its derivation from the mesenchyme. The mesothelium of the yolk-sac of pig embryos between 5 and 12 mm. does not produce hæmoblasts. Nor is there any satisfactory evidence that the mesothelium of the body-stalk and chorion function to this end. The mesenchyme may differentiate directly into endothelium or into hæmoblasts. Hæmoblasts arise extensively at the 10 mm. stage from the endothelium of the yolk-sac blood-vessels. The endothelia of the

* Amer. Journ. Anat., xix. (1916) pp. 277–303 (2 pls.).

hepatic sinusoids and mesonephric glomeruli of this stage also show extensive hæmopoietic capacity.

Giant cells, both mono- and polynuclear, are abundantly present in the yolk-sac only at about the 10 mm. stage of development. They may arise from endothelium or directly from hæmoblasts. They are giant hæmoblasts, and apparently function as multiple erythroblasts in which normoblasts differentiate intracellularly. The several stages in hæmopoiesis, represented successively by hæmoblasts, erythroblasts, and normoblasts, with transition stages, are abundantly present in the yolk-sac of embryos from 5 to 15 mm.

**Cell-clusters in Dorsal Aorta of Mammalian Embryos.***— V. E. Emmel finds in embryos of mouse, rabbit, and pig certain well-defined cell-masses or clusters in the aorta. Most of the component cells are comparable to the basophilic and phagocytically active cells or macrophags (mesamœboids?) in the embryonic circulation. Their constancy of occurrence, firm attachment, and restriction to the ventral wall of the aorta show that these clusters are not chance accumulations. It is concluded that they have arisen from the vascular endothelium.

An intimate association and causal relationship can be demonstrated between the formation of the aortic clusters and the developmental processes involving the atrophy of certain aortic rami and the establishment of the permanent intestinal arteries of the adult Mammal. The endothelium in degenerating stems of the aortic rami is stimulated (evidently through certain toxic conditions arising in the retrogressive vessels), to phagocytic and proliferative activities giving rise to infra-arterial cell masses constituting a primary source of the origin of the aortic clusters. Thus under certain abnormal conditions endothelial tissue, ordinarily passive, may in both embryo and adult assume proliferative activities.

**Development of Bird's Lung.**†—W. A. Locy and Olof Larsell have made a very careful study of the development of the lung as a whole, and of the intrapulmonary bronchial tree. As Campana pointed out, there is no "bronchial tree" in the adult bird's lung in the sense in which this designation is used for mammals. No bronchial twigs of the adult avian lung terminate blindly. On the contrary, there is established a network of intercommunicating passages forming bronchial circuits. The resemblance is closer to the capillary connexion between arteries and veins than to a tree.

From their earliest formation, the lung pouches are lined by endoderm, and this internal cavity is the basis from which hollow buds arise to form the branches of the bronchial tree. The endodermic tube lies in a layer of mesenchyme that is bordered on the surface towards the pleuro-peritoneal cavity by a well-defined layer of mesothelium. Accordingly, the external boundaries of the lung are formed by a wall

* Amer. Journ. Anat., xix. (1916) pp. 401–21 (2 pls.).
† Amer. Journ. Anat., xix. (1916) pp. 447–504 (46 figs.).

of mesoderm which gives no indication of the internal configuration of the endodermic lining. The authors give an account of this exceedingly complex internal configuration and of the stages in its development.

**Pulmonary Circulation in Chick.***—Theodore L. Squier finds that the pulmonary circuit is complete, though not necessarily in its definitive form, in the 72-hour chick. Blood must flow through the pulmonary system at a very early stage, although owing to the relative resistances in this and the general systemic circulation the amount passing through the lungs is undoubtedly small. With the general enlargement of the pulmonary system, and finally upon the collapse of the last aortic arch, a circuit adequate for respiratory purposes is not only at hand, but is automatically put in use. The pulmonary vein may be simply a specially developed part of an indifferent plexus present from the beginning in the region from which the lungs grow, the sole survivor of numerous primitive vessels that drain the region surrounding the lung primordium. Or it may be that a median dorsal outgrowth from the sinus wall connects secondarily with the lung capillaries.

**Development of Liver and Pancreas in Amblystoma.**†—E. A. Baumgartner finds that the liver in this Amphibian begins as a median ventral projection of the lumen of the gut, then as an anterior outpouching from this lumen. There is a later shifting of the posterior part of the liver to the right and dorsally, due to crowding of the stomach and development of the duodenum on the left. A later growth on the left side results in an adult organ with right and left parts, the right side always remaining more dorsal on the lateral side of the stomach.

The ductus choledochus develops as the early anteriorly directed lumen from the gut. The right and left hepatic ducts develop as divisions of the ductus choledochus, and by division and growth form the hepatic rami and branches. The gall-bladder begins as a median ventral outpouching of the posterior part of the liver-primordium.

The ventral pancreatic primordia are ventro-lateral evaginations of the gut caudal to the cystic primordium. The dorsal pancreatic primordium is a single median dorsal evagination. The ventral pancreatic ducts are constrictions of the two ventral pancreatic primordia; they afterwards unite in one. The dorsal duct remains a single stem with short lateral branches.

**Life-history of Gurnard.**‡—Alexander Meek has made a study of *Trigla gurnardus*, with special reference to the migrations. He uses the word *denatant* for migrations with the current, and *contranatant* for migrations against the current. To begin with, there is a denatant drift of eggs and larval stages lasting for a number of weeks, a

* Anat. Record, x. (1916) pp. 425–38 (2 pls. and 3 figs.).
† Amer. Journ. Anat., xix. (1916) pp. 211–75 (4 pls.).
‡ Rep. Dove Mar. Lab., Cullercoats, 1915, pp. 9–15 (6 figs.).

gradual sinking in the water, and a coming to rest in depths of from 5–30 fathoms, but for the most part in 10–25 fathoms.

Next spring a denatant inshore migration occurs and a concentration of the products of the previous year's spawning season. There is a contranatant migration into deeper water again at the end of summer. Thereafter there is a seasonal migration from deep water to shallow water, the spring migration being from the north and the autumn migration to the north (east coast of Britain, north of the Wash). With increase in size the outward migration is still further to the north and into deeper water. Coming maturity impels the fish to migrate in winter contranatantly to a still greater distance, from which it will return with the spawning migrants. The outward migration may associate the fish with spawners of a region related to another school. After spawning the spent fish join the summer denatant migrants and migrate later than these, and evidently further than these for winter.

**Spawning in Algerian Sparidæ.***—J. B. Bounhiol and L. Pron find that there are two annual periods of reproductive activity in some Sparidæ. In *Pagellus erythrinus* there is spawning between 1st March and 1st August, at a temperature of at least 16° C. at depths of 20–30 metres. It is preceded by gradual ovarian development lasting for two months; it is followed by retrogressive changes. In the last two weeks of October and the first week of November there is rapid ovarian development; then spawning occurs; then retrogression sets in, completing itself about the middle of December. The temperatures at the time of the second reproductive period are from 21° to 15° C. at a depth of 30 metres. Various facts relating to reproductive precocity and sex dimorphism in Sparidæ are chronicled.

**Development of Erythrocytes from Hæmoglobin-tree Cells.**†—P. G. Shipley explanted some tissue from the area opaca of chick embryos before the formation of blood islands and the elaboration of hæmoglobin. The cultures were planted in the blood-plasma of an adult hen after Harrison's method, and in some of them hæmoglobin-bearing cells developed from amœboid colourless elements apparently of mesoblastic origin. In all the cultures (120) there was vigorous cell proliferation and migration which began within an hour after the culture slides were placed in the incubator and continued for three to four days. This growth was so exuberant, and cell migration was so rapid, that in twenty-four hours the layer of new cells was perceptible without the aid of a lens, and in forty-eight hours a ring of new tissue 3 or 4 mm. in diameter was formed about the original explant. The study of the cultures showed that development and differentiation of hæmoglobin-bearing cells is possible in tissue transplants removed from the normal environment to a culture medium. The development of erythrocytes (mostly abnormal, however, in size and shape) from amœboid colourless ancestors and the specialization and assumption of

* C.R. Soc. Biol. Paris, lxxix. (1916) pp. 140–3.
† Anat. Record, x. (1916) pp. 347–53 (2 figs.).

rhythmic contractility on the part of embryonic mesoderm cells under cultural conditions, show that the life of cells in culture is not merely a series of "survival phenomena" on a down-grade.

**Numerical Results of Diverse Systems of Breeding.***—H. S. Jennings gives formulæ for finding in any generation the results of continued breeding by a given system, with respect to a single pair of alternative characters. Sex-linked characters and typical characters are dealt with separately. Formulæ are given for the results of random mating, assortative mating, selection of dominants, self-fertilization and in-breeding. In each case the diverse results obtained by beginning with different parental combinations are given. It is shown that the results in successive generations form fractions such as may be obtained by compounding in various ways several well-known arithmetical series.

**Inheritance of Finger Peculiarities.**†—H. Drinkwater describes peculiarities in fingers persistent for at least four generations. The most striking peculiarity is a marked reduction in the length of the index and middle fingers, so that the ring finger projects far beyond the others. It is of the nature of brachydactyly, but there all the fingers are affected. Both hands are similar. An interesting point is the occurrence of an extra triangular bone interposed in the index and middle fingers between the epiphysis of the proximal phalanx and the head (epiphysis) of the metacarpal. It is probably due to an abnormal segmentation of the row of mesoblast cells which form the primitive basis for the osseous skeleton of the digit. The condition illustrates Mendelian inheritance. It is not transmitted by the normal members. There are thirty-six descendants of the abnormal members of the family, and fifteen of these show the abnormality.

**Development of Biliary System in Animals without Gall-bladder.**‡—Richard E. Scammon has studied in this connexion the lamprey, the pigeon, and the rat. 1. In the lamprey a complete biliary apparatus is formed and persists throughout the larval or Ammocœte stage. At the time of the transformation of the larval to the adult form there is a total degeneration of both gall-bladder and ducts. 2. In the pigeon the gall-bladder is developed apparently in a perfectly normal way, and later, in the majority of cases at least, is completely lost. The duct to which it is attached persists and grows to some size. This case is complicated, however, by the presence of a larger anterior hepatic duct which opens independently into the duodenum and is never associated with the gall-bladder. 3. In the rat there is at most but a trace of a cystic primordium in very early stage, and this soon disappears.

The author has not observed any common factors which would

* Genetics, i. (1916) pp. 53–89.
† Journ. Anat. Physiol., l. (1916) pp. 177–86 (14 figs.).
‡ Anat. Record, x. (1916) pp. 543–58 (10 figs.)

account for the absence of the gall-bladder in these three cases. In the rat it is possible that the rapid and early reduction in size of the yolk-stalk, which leaves the foregut wall quite short antero-posteriorly, may be a factor in inhibiting the development of the gall-bladder. In Mammals generally, as compared with most lower forms, there is a distinct shortening of the liver primordium and a tendency towards consolidation of the cystic and hepatic portions. This has been well shown in Pensa's recent work on *Bos taurus*, and it may be that the rat is but an extreme example of the consolidation.

It is possible that there are in man two types of casual inhibition of the development of the biliary apparatus. In one type the entire pars cystica of the liver primordium is suppressed, and this would be represented by the rare cases in which both gall-bladder and bile-ducts are absent. In the other type only the gall-bladder primordium is lost, either early or late in development, and this would be represented by the more common anomaly of the absence of the bladder only. The large size of the bile-ducts is noticeable in both pigeon and rat embryos. This seems to be a compensation for the absence of the usual bile reservoir in the form of a definite sac.

### *b.* Histology.

**Functional Significance of Mitochondria.***—E. V. Cowdry defines mitochondria provisionally as substances which occur in the form of granules, rods and filaments in almost all living cells, which react positively to janus green, and which by their solubilities and staining reactions resemble phospholipins (complex compounds of fatty acid, phosphorus and nitrogen), and to a lesser extent, albumins. Chemically they may be combinations, in varying amounts, of phospholipins and protein. They play an active part and fundamental rôle in cell activity, though just what the part is remains obscure. In early stages of development they are the only formed elements in the cytoplasm. The movements of mitochondria in living cells tend to confirm mistrust in the doctrine of a cytoplasmic reticulum.

**Wandering Cells in Loose Connective Tissue of Bird.**†—Vera Danchakoff has studied the many kinds of amœboid cells found in the loose connective tissue of the hen. Some of them are the direct descendants of the amœboid cells produced by the mesenchyme of the embryo. The embryonic mesenchyme appears to be a diffuse primordium for both lymphopoiesis and granuloleukopoiesis, and there remains a power of similar differentiation in the whole loose mesenchyme as well as in special hæmatopoietic organs. The mesenchyme is polyvalent in its potencies of development, the differentiation in various directions (different kinds of blood-cells), being directed by the environing physiological conditions.

* Amer. Journ. Anat., xix. (1916) pp. 423–46.
† Anat. Record, x. (1916) pp. 483–92.

**Cranial Subarachnoid Spaces.***—Lewis H. Weed distinguishes "serous cavities" derived from the cœlom and those cavities which have characteristic organs of elaboration and specialized arrangements for the absorption of their individual fluids. Those of the second type are the aqueous chamber of the eye and the cerebro-spinal spaces. He has studied the formation of the subarachnoid spaces in the cranium of the pig. The process involves a dilatation of the early mesenchymal spaces, a disruption and breaking down of certain of the syncytial strands, and a survival of certain selected strands, to form the permanent subarachnoid channels. In addition to this rarefaction of the mesenchyme, there is a process of condensation in this tissue giving rise ultimately to the arachnoid membrane and reinforcing the trabeculæ. Associated with the breaking apart of the syncytium of the perimedullary mesenchyme, there are invariably found large coagula of albuminous material, apparently an index of the circulation through the spaces of the embryonic cerebro-spinal fluid.

**Regeneration in the Tail of Frog Tadpole.**†—H. E. Metcalf has made a histological study of the cell changes in the epidermis during the early stages of regeneration in the tail of the tadpole of *Rana clamitans*. The amphibian tail was chosen because of the size of the cells, and the ease with which they are studied under the Microscope. The special aim of the paper is to give an account of the migration of the epidermal cells to cover the wound, and to describe the cytoplasmic and nuclear changes in the migrating cells. Within one hour after cutting there is a muscle contraction, which decreases the surface of the wound and brings the epidermis of the two sides of the tail together both above and below the notochord, where the epidermis fuses. There is a migration of the epidermal cells over the blood-clot which is always formed within twelve hours. This is an active migration of the epidermal cells, especially those of the outer layer, with no sign of multiplication either by mitotic or amitotic cell-division. There is a decrease in the ratio of cytoplasm to nucleus in the migrating epidermal cells, as compared with that in the normal epidermis. The ratio seems to increase slightly as the cells begin to leave their regular positions, and then to decrease steadily in the actively migrating cells. As the cells are removed from their normal position in relation to the blood-vessels, this decrease may be due to starvation. The rate of metabolism in the individual cells is probably high, and they may be forced to rely on the energy contained in the cytoplasm, and so use it up during migration. If the views of Minot and Conklin can be applied to these cells, the decrease in the ratio of cytoplasm to nucleus would indicate a rejuvenescence of differentiated epidermal cells. Migration ceases at about twenty-four hours, and the ratio returns to normal in the epidermal cells. The period of time from twenty-four to forty-eight hours is occupied by the absorption of the clot, and the cells are in a resting condition. At forty-eight hours regeneration by mitosis begins. No

* Anat. Record, x. (1916) pp. 475–81.
† Trans. Amer. Micr. Soc., xxxiv. (1915) pp. 167–84 (10 figs.).

evidence has been found that amitosis is a factor in the regeneration of the tadpole's tail.

**Scales of Freshwater Fishes.***—Arthur T. Evans has made a study of the minute structure of the scales of various types—*Perca flavescens*, *Stizostedion vitreum*, *Boleosoma nigrum*, various Centrarchidæ, and the pike. His general result is that the minute features of scales are very distinctive. Many striking similarities are seen between the members of the same family. In every case the scales of the more primitive fish show characteristics of primitive scales, and the scales of the more specialized fishes show characteristics of highly developed scales.

**Structure of Phallostethidæ.**†—C. Tate Regan describes the structure of both sexes of *Neostethus lankesteri* g. et sp. n. and *N. bicornis* sp. n., minute fishes in the family Phallostethidæ. He compares them with *Phallostethus dunckeri* which he previously described. Very remarkable is the complex priapium of the males. It seems to be an entirely new formation; its appendages, bones, muscles and glands are not to be homologized with any structures found in the female fish or in other Cyprinodonts. This suggests that intermuscular connective tissue may give rise to cartilaginous or bony elements whenever and wherever the necessity may arise. The precise use of the priapium in the intercourse of the sexes cannot be determined without a study of the actual behaviour. Its extraordinary complexity finds a parallel in the mixopterygia of Selachians.

**Sea-water as a Medium for Tissue Cultures.**‡—M. R. Lewis has shown from the success of numerous cultures that the dilution of sea-water affords a simple and exact way by means of which can be obtained a medium which is not only isotonic with the plasma of any given animal, but which also contains the necessary salts in the same proportion as does the plasma of the animal.

In 1878 Fréderiq showed that the blood and hæmolymph of marine invertebrates is isotonic with the sea-water, and in 1908 Macallum showed that the plasma of higher animals is not changed in composition from the sea-water, but is simply more dilute. The solution Lewis used was formed from 90 c.cm. of the dilution of sea-water (isotonic with the plasma of the animal), 10 c.cm. of bouillon made from the muscle of the animal in question, 0·02 grm. of $NaHCO_3$ to neutralize the acid formed by the culture, and 0·25 grm. of dextrose to supply the energy for the growth of the tissue. The cultures must be aseptic, and should be kept in a warm chamber at 30° C. when the tissue is from a warm-blooded animal, and at the temperature normal to the animal when the cultures are from the tissue of a cold-blooded animal.

* Trans. Amer. Micr. Soc., xxxiv. (1915) pp. 255–68 (3 figs. and 1 table).

† Proc. Zool. Soc. London, 1916, pp. 1–26 (4 pls. and 15 figs).

‡ Anat. Record, x. (1916) pp. 287–99 (4 figs.).

**Life of Peripheral Nerves in Plasma.***—Ragnvald Ingebrigtsen has experimented with pieces of nervous tissue from young Mammals. The Wallerian degeneration—i.e. the death and disintegration of the axis cylinders and myelin sheath, which takes place in peripheral nerves incubated in Ringer solution and serum—does not occur in plasma. Peripheral nerves incubated in plasma give rise to no growth. The same is true of peripheral nerves in Wallerian degeneration up to the fourth day. Peripheral nerves in Wallerian degeneration from the fifth day give rise to a growth of the syncytium of Schwann. In cultures from later stages there is progressive growth of the same structure. It is evident that the proliferation of the cells of Schwann is directly produced by the degeneration of the axis cylinder and its myelin sheath. In no case was growth of axis cylinders observed. The growth of the syncytium of Schwann from degenerating nerves affords a basis for an anatomical conception of the centrifugal orientation of growing axis cylinders in regeneration. Morphologically there is a striking resemblance between the syncytium of Schwann and neuroglia growing in plasma.

**Effects of Inanition on Thyroid and Parathyroid Glands of Albino Rat.**†—C. M. Jackson has observed the following changes in young rats. The follicular epithelium is atrophied with reduction in height. The nuclei are rarely hypochromatic (various stages of karyolisis), but hyperchromatosis is more typical, the nuclei usually presenting some stage of pycnosis. In the earlier stages the nucleus may be nearly normal in size and structure, excepting a pale, homogeneous coloration of the nuclear background. In more advanced stages the nucleus diminishes in size, with deepened coloration, forming a dense, deeply-staining, homogeneous mass (typical pycnosis). In extreme cases the nucleus becomes fragmented (karyorrhexis). Neither mitosis nor amitosis is found.

The cytoplasm is usually reduced in amount considerably more than the nucleus. It may show no marked change in structure (simple atrophy), but usually becomes rarefied, with a marked vacuolization ("hydropic degeneration") and loss of the normal granulation. This is especially marked in the few cells where the cytoplasm has lost but little in volume. In some cases the cytoplasm may become homogeneous ("colloid" type), and in advanced stages may disintegrate, forming irregular, deeply-staining (eosinophile) masses of varied appearance. The intrafollicular changes, which are not usually marked, are also dealt with.

In the adult rats the changes of the thyroid gland are in general like those in the younger rats, but the interpretation is complicated by the fact that degenerative changes are frequent in normal (control) rats.

The parathyroid glands appear to be relatively larger in the female. They apparently belong to that group of organs in which growth persists in young rats, even when held at maintenance (constant body

* Journ. Exper. Med., xxiii. (1916) pp. 251–64 (8 pls.).
† Amer. Journ. Anat., xix. (1916) pp. 305–52 (14 figs.).

weight) by underfeeding. In adult rats during acute and chronic inanition, the reduction in the size of the parathyroids is nearly proportional to that of the body as a whole. In minute structure the parathyroid is relatively more resistant than the thyroid to inanition. The changes in the structure of the epithelial cells are somewhat similar to those described for the thyroid, though in general less marked.

### c. General.

**Effects of Atmospheres Rich in Oxygen.***—Howard T. Karsner has subjected rabbits to high oxygen partial pressure (80 to 96 p.c.) under ordinary barometric pressure. In twenty-four, or, more commonly, forty-eight hours there resulted congestion, edema, epithelial degeneration and desquamation, fibrin formation, and finally pneumonia, probably of irritative origin and to be described as a fibrinous bronchopneumonia.

**Mammæ of Rat.**†—J. A. Myers has studied the growth and the gross relations of the ducts and nipples of the albino rat from birth to the tenth week. The number of glands varies between ten and thirteen, the normal being six pairs. Only one primary duct is present in each gland; its branching is often dichotomous; anastomoses sometimes occur between the ducts of a single gland; there is considerable individual variation in development; the characteristic distribution and ramification of the ducts apparently depend upon the space available for their growth; the growth and branching of the ducts goes on at an unusually rapid rate about the ninth week, probably corresponding to the age of puberty; a distinct lumen is present at birth in all the ducts distal to the intra-epidermal portion of the primary duct; at the end of the second week the lumen extends to the surface of the nipple.

**Abnormality in Frog.**‡—R. W. Harold Row describes a case of symmetrically abnormal hind feet in *Rana temporaria*, which showed an absence of the first digit. The calcar was present normally, and there was no trace of any mutilation.

**Abnormalities in Vascular System of Frog.**§—Walter E. Collinge notes the occurrence of twenty-two abnormalities in about 500 specimens, and describes the ten most important of these. Some are of interest in illustrating the persistence of embryonic stages, while others may be regarded as reversions to ancestral conditions. Figures are given of a persistent caudal vein, of a renal-portal vein continuous with the inferior vena cava, of a looped renal-portal, of a double renal-portal, of a persistence of the embryonic right posterior cardinal sinus, of the persistence of the connexion with the heart of the anterior abdominal vein on both sides, and so on.

* Journ. Exper. Med., xxiii. (1916) pp. 149–70 (4 pls.).
† Amer. Journ. Anat., xix. (1916) pp. 353–88 (4 pls. and 6 figs.).
‡ Proc. Zool. Soc. London, 1916, pp. 87–9 (1 fig.).
§ Journ. Anat. Physiol., l. (1915) pp. 37–42 (12 figs.).

**Abnormal Spinal Cord in Toad.***—W. M. Smallwood describes a toad in which the spinal cord was only half the normal length. A section showed that the neurocœle was not central, but pushed ventrally: that the grey substance was more predominant than usual; that the dorsal grey commissure was greatly enlarged; that the dorsal column was nearly double the normal size; and that there was a small funicular region.

**Experimental Edema in Frogs.**†—Arthur Russell Moore has analyzed the factors involved in experimental edema. In the normal frog the water which is being continually absorbed through the skin is removed by the lymphatics and veins. When a limb is completely ligatured, liquid accumulates rapidly under the ligature. This liquid consists of transudate and of water absorbed through the skin by osmosis. Removal of the superfluous liquid is prevented because both veins and lymphatics are closed. The lymph therefore tends to become more and more dilute, and the muscle correspondingly swollen with the continued absorption of water. In short, the phenomena of edema develop below a complete ligature because lymph and tissue take up water osmotically, and the avenues for its removal are blocked. In the case of edema produced by a lymphatic ligature, the lymph formed in the normal fashion is retained, while the absorbed water passes into the capillaries and is removed.

**Reactions of Necturus.**‡—Mary H. Sayle has studied the reactions to skin stimuli exhibited by *Necturus maculosus*, the well-known primitive Amphibian of American fresh waters. The skin is everywhere sensitive to tactile stimulation. The regions about the nostrils, gills and tail are most sensitive, and the back least sensitive. The whole body surface is sensitive to chemical stimuli, the reactions being characteristic for the different regions stimulated. The gills are usually the most sensitive region, with the nostrils and head following in order. The animal is more sensitive to nitric than to hydrochloric or sulphuric acid. It is least sensitive to acetic acid. It is more sensitive to potassium sulphate than to potassium chloride. When any region of the body is fatigued for a given chemical, it rarely responds to tactile stimuli, although it usually reacts to other kinds of chemical stimuli. The animal is sensitive to considerable changes in temperature. All parts of the body are sensitive to hot water (70° C.), but the gills, head, and nostrils are the most sensitive regions. The creature is negatively phototropic and comes to rest in shaded areas. Both the eyes and skin are photoreceptors, and the stimulation of either brings about negative reactions. The head and tail are the most sensitive regions.

**Symmetry and the Differentiation of Species.**§—S. J. Hickson notes the general association of bilateral symmetry with active habits

* Anat. Record, x. (1916) pp. 515–6 (2 figs.).
† Amer. Journ. Physiol., xxxvii. (1915) pp. 220–29.
‡ Journ. Animal Behaviour, vi. (1916) pp. 81–102 (1 fig.).
§ Mem. and Proc. Manchester Lit. and Phil. Soc., lx. (1916) pp. 1–15.

and of radial symmetry with sedentary or floating life, and collecting food from any direction. Meristic variability in important organs is much greater in radially symmetrical forms than in bilaterally symmetrical forms where a balance must be kept. In sedentary colonies plasticity of shape is of great vital importance. "With this great plasticity in the method of growth, and therefore the great accommodation of shape to the conditions of the environment, many of the characters used by systematists for the distinction of species must be regarded as of very little value." In reference to the Pennatulacea Hickson shows how variable or plastic characters may become less variable or plastic as a transition is made from radial to bilateral symmetry, and how the increasing rigidity of certain characters leads in some cases to the differentiation of the discontinuous groups which are recognized as species.

**Larval and Post-larval Fishes of 'Terra Nova' Expedition.***— C. Tate Regan reports on a post-larval example of the strictly Antarctic *Notolepis coatsii* Dollo, and on a series illustrating the development of the more widely distributed *Myctophum antarcticum* Günth. The larval and post-larval specimens of the latter were all taken in the Subantarctic zone; the adult ranges throughout the Antarctic, Subantarctic and South Temperate zones. A second Antarctic species of *Paraliparis* is reported, and named *P. terræ-novæ* sp. n. The collection also included young stages of some Nototheniiform fishes—*Pleuragramma*, *Pagetopsis*, and *Chionodraco*. A number of fishes collected from Tropical and South Temperate zones are also dealt with.

It is well known that the truth of the theory that ontogeny repeats phylogeny is shown by almost every Teleostean fish in the development of its caudal fin, which is at first ventral and then becomes terminal. Two rather puzzling developmental features, the migration forwards of the dorsal fin in the Clupeidæ and the migration backwards of the anus in *Notolepis*, *Paralepis*, etc., may possibly be explained by the same theory. This is discussed.

The pectoral fins, which are principally concerned with balancing, are usually present in the youngest larvæ, and the permanent fin-rays appear at a very early stage. As a rule the caudal, used for propulsion, is the next fin to develop. The hypurals and fin-rays make their appearance below the notochord, and then by flexion of the latter are brought into a terminal position. Afterwards the dorsal and anal rays develop in the embryonic fin-fold and the pelvic fins grow out. The deviations from this, the usual, order are considered.

Pelagic larvæ are characterized by the absence of accessory organs of respiration and of adhesive organs; by their invisibility; by their buoyancy and balance; by their well-developed sense-organs; and by the frequently defensive bones of the head, which are armed with spines.

Except in a few groups, e.g. Apodes, there are no features that characterize pelagic larval fishes as belonging to one order or another,

* British Antarctic ('Terra Nova') Expedition (Zool.) i. (1916) No. 4, pp. 125–56 (10 pls. and 5 figs.).

and it is not easy to determine their systematic position unless they are sufficiently advanced towards the structure of the adult fish. In all cases assistance is afforded by the number of myotomes and of fin-rays, if these be developed.

**Food of Small Shore Fresh-water Fishes.***—A. S. Pearse has studied this in the lakes, swamps, and streams near Madison, Wisconsin. Of the sixteen species examined, nine (viz. basses, sunfish, darters, miller's thumb, and silversides) obtained their living largely from insects or their larvæ. Among the other seven species, two had the major part of their food from Ostracods, two from Copepods, one from Cladocera. Thus Entomostraca form the main food of six species. The remaining two (*Notropis heterodon* and *N. cayuga*) showed mud and detritus; nine of the species are too small to be used by man, but they are probably of some importance as food for larger forms and in other ways. The seven species used by man depend mainly on insects, insect larvæ, and Entomostraca. It is noted by Forbes that the very young perch feeds on Entomostraca and minute Dipterous larvæ; after it is $1\frac{1}{2}$ in. long it depends more on insects; as an adult it devours molluscs, crayfishes, and fishes.

**Transfusion of "Kept" Red Blood Corpuscles.**†—Peyton Rous and J. R. Turner have succeeded in keeping erythrocytes of the rabbit for a fortnight in mixtures of blood, sodium citrate, saccharose and water. Transfusion experiments were carried out by which a large part of the blood of a rabbit was replaced by "kept" blood. The erythrocytes preserved *in vitro* and reintroduced remained in circulation and function so well that the animal showed no disturbance. Cells kept for longer periods, though intact and apparently unchanged when transfused, soon leave the circulation. They are disposed of without harm. Perhaps "kept" human cells could be similarly used to replace lost blood.

**Protection of Pathogenic Micro-organisms by Living Tissue Cells.**‡—Peyton Rous and F. S. Jones have made experiments, e.g. with *Bacillus typhosus* and the leucocytes of the guinea-pig, which go to show that living phagocytes are able to protect ingested organisms from the action of destructive substances in the surrounding fluid, and even from a strong homologous anti-serum. There is evidence that the protection by phagocytes is largely, if not entirely, dependent on their being alive. It remains to be determined how far the protection of micro-organisms by living tissue cells, especially cells incapable of killing the micro-organisms, is important in disease processes. An infective agent may be walled off from the action of body-fluids and kept alive for a long time.

* Bull. Wisconsin Nat. Hist. Soc., xiii. (1915) pp. 7–22.
† Journ. Exper. Med., xxiii. (1916) pp. 219–37 and 241–8.
‡ Journ. Exper. Med., xxiii. (1916) pp. 601–12 (1 pl.).

## INVERTEBRATA.

### Arthropoda.

#### α. Insecta.

**Insects in Relation to Disease.***—R. M. Buchanan discusses the rôle of insects in spreading diseases. Mosquitoes have checked civilisation by disseminating malaria and yellow fever; the tsetse-flies have carried sleeping sickness over the tropical area of Africa; other insects have to do with plague, typhus, and relapsing fever; the house-fly is credited with a share in the transmission of typhoid fever, infantile diarrhœa, dysentery, and cholera. Mechanical transmission is illustrated by the house-fly, and inoculation by means of biting mouth-parts by the tsetse-fly. The egg of *Musca domestica* takes from 8 hours to 3 days to develop, the maggot from 5–8 days to 6–8 weeks, the pupa 3–4 to 5–7 days or 2–4 weeks, the imago to become mature 14–18 days. The shortest time required for an ovum to give rise to a winged fly is 8½–15 days, the longest time taken is 8–12 weeks. The shortest time for the whole life-cycle is 3–4 weeks, the longest 10–15 weeks. The structure, habits, and enemies of the house-fly are discussed. The fungus *Empusa muscæ* and the mite *Gamasus musci* are dealt with. Attention is also directed to the lesser house-fly (*Fannia canicularis*), the latrine-fly (*F. scalaris*), and the stable-fly (*Stomoxys calcitrans*), and other flies. In some detail the author treats of the transmission of trypanosomes by tsetse-flies.

**Study of Lac Insect.**†—A. D. Imms and N. C. Chatterjee have made a study of *Tachardia lacca*, the Coccid which produces the Indian lac. The lac is a resinous secretion or exudation, from yellow to reddish brown, produced in large quantities by the female, in very small quantities by the male. It appears to be a product of the epidermis. The insect is double-brooded. The larvæ issue from the resinous incrustations of the females in large numbers and search for succulent twigs, in which they insert their mouth-parts. They become gradually covered with lac. About a month after the fixation of the larvæ of the first brood, the male insects emerge. In the case of the second brood the males emerge about three and a half to five months after fixation. Those of the first brood may consist of both winged and wingless individuals, while those of the second brood are wingless. After the females have been fertilized by the male the secretion of lac becomes much greater. From two to three months after the emergence of the males the young larvæ appear. The parent female then rapidly dies, and her shrivelled skin is left in the central cavity of the incrustation which enveloped her. As in most Coccidæ there is a pupal stage in the life-history of the male and a highly evolved insect emerges, while in the case of the female there is only degeneration. The

* Glasgow Med. Journ., Jan. 1916, p. 1–28 (5 pls. and 29 figs.).
† Indian Forest Memoirs, iii. (1915) Calcutta, pp. 1–42 (3 pls.).

occurrence of dimorphic males (winged and wingless), so marked in *Tachardia*, is rare among Coccidæ. Besides lac the insects produce honey-dew, which attracts ants and forms a medium for fungi. The lac-insect is extensively parasitized. The authors found thirty-one species of parasites, hyperparasites and predaceous insects affecting it.

**Structure and Life-history of Telephorus lituratus.***—Olga G. M. Payne gives an account of the life and habits of the larvæ. They are primarily carnivorous, but may turn to vegetable food. When annoyed they usually eject blackish fluid from the mouth. They normally pupate in burrows in clay soil. The external features of the pupæ are described. The mouth-parts and other external features of the adult are also dealt with, and a detailed account is given of the structure of the larva. The mid-gut is very dark. This appears to be due partly to the dark coloration of the epithelial layer itself and partly to the blackish fluid secreted. The rest of the gut has a chitinous lining. The abdominal fat body contains what are probably excretory concretions. The heart seems to be a continuous muscular tube. The brain is in the lower half of the first thoracic segment, not in the head. There are minute dorsal glands, a pair to each segment of the thorax and abdomen. Their function is unknown.

**Making and Oviposition in Crane-Fly.**†—John Rennie describes these processes in *Tipula paludosa*, of which there is only one generation in the year in the north of Scotland. The male alights above the female and passes his abdomen below her. The widely gaping claspers of the male seize the female on the thickened basal part of the ovipositor. The male releases his hold by the limbs and turns so as to face in the opposite direction from the female. This position is maintained until separation takes place. The antennæ of the male continue in active backward and forward movement, and the halteres quiver at frequent but irregular intervals. In oviposition the female stands vertically with the ovipositor pushed well into the ground. Spasmodic jerks of the hinder part of the abdomen indicate the expulsion of the eggs one by one. About half-a-dozen may be deposited at the same spot, but frequently fewer. The eggs of a young female mostly show black through the skin. Advanced female pupæ have the abdomen filled with salmon-pink ovaries A second set of ova matures after the oviposition, which suggests a second laying.

**Study of Diptera.**‡—Percy H. Grimshaw discusses the importance of the study of Diptera. Some are the intermediate hosts of human parasites, others are the mechanical distributors of disease. Epidemic outbreaks of typhoid fever, summer diarrhœa, diphtheria, smallpox, and other ailments are largely due to the agency of the common House-fly. Many, like the Hessian-fly, devastate crops; others like the Bot-flies attack domestic animals. The annual loss due to Dipterous agencies is

* Journ. Zool. Research, i. (1916) pp. 4–32 (2 pls. and 18 figs.).
† Ann. Applied Biol., ii. (1916) pp. 235–40 (1 pl.).
‡ Scottish Nat., 1916, pp. 85–8.

reckoned in millions of pounds sterling. There is great need for a comprehensive work on British Diptera, which number considerably over 3000. It is interesting that out of the seventy-four existing families of Diptera no fewer than sixty-four are represented in the British Fauna.

**Diptera Scotica.***—Percy H. Grimshaw continues his survey of the Diptera of Scotland, and deals in this instalment with those from the Western Isles. The list includes 380 species. Jura heads the list with 166: then follow Lewis with 150, South Uist with 148, North Uist with 90, and Skye with 78. Of the smaller islands we have Benbecula with 27 species, and Iona with 22. But no deductions can be drawn until the islands are thoroughly and systematically searched on a uniform plan.

**As regards Lice.**†—J. Parlane Kinloch has continued his investigation of the best methods of destroying lice. As Bacot has also shown, they do not survive immersion in boiling water. Naphthalene and creosote (as in N.C.I. powder) have a strong insecticidal action. The lethal power of naphthalene is greater in the commercial form than in pure naphthalene, and seems to depend in great part on the presence of hydrocarbons and coal-tar derivatives other than pure naphthalene The iodoform which is mixed with naphthalene and creosote in N.C.I. powder has a feeble insecticidal action, but increases the adhesiveness of the powder to cloth. The cheaper magnesium silicate might be substituted for it. The insecticidal power of naphthalene-creosote powders gradually diminishes when they are exposed in the open air. All lice exposed to an atmosphere of sulphur dioxide die within five seconds. For emergency cleansing of clothing immersion in petrol is most suitable, for the scalp tetrachlorethane on cotton-wool.

**Malaria Parasites in American Species of Anopheles.**‡—W. V. King finds that *Anopheles punctipennis* is an efficient host of the organisms of tertian and æstivo-autumnal malaria, and *A. crucians* of at least æstivo-autumnal malaria. Information has been obtained as to the relative susceptibility of these two species and of *A. quadrimaculatus*, which has been known as an efficient host since Thayer's experiments in 1900. The indications are that *A. punctipennis* and *A. quadrimaculatus* are equally susceptible to infection with *Plasmodium vivax*; while with *P. falciparum*, *A. crucians* showed the highest percentage of infection (75 p.c.), *A. punctipennis* second (33 p.c.), and *A. quadrimaculatus* third (23 p.c.).

**Beet or Mangold-fly.**§ — A. D. Imms discusses the distribution and life-history of *Pegomyia hyoscyami* var. *betæ*, which attacks beet,

* Scottish Nat., 1914, pp. 205–13, 234–6, 258–62, 276–81; 1915, pp. 115–19; 1916, pp. 134–8.
† British Med. Journ., June, 1916, pp. 1–11.
‡ Journ. Exper. Med., xxiii. (1916) pp. 703–16 (8 pls.).
§ Journ. Board Agric., xxii. No. 9 (December, 1915) 3 pp.

mangold, spinach, henbane, deadly nightshade, and other plants. The female insect deposits her eggs on the underside of the leaf, generally in neat parallel rows. On hatching, the maggots mine the leaf, devouring the soft parenchymatous tissue between the upper and lower epidermis. There are at least three broods of the insect in the year, the average time for the life-cycle of one brood being about thirty-six days. During the cold months there is hibernation in the pupal stage at about two inches below the surface of the soil.

**Hymenopterous Parasites.***—J. T. Wadsworth reared from the pupæ of the cabbage-root fly, *Chortophila brassicæ*, the following Hymenopterous parasites: *Phygadeuon fumator* Grav., *Atractodes tenebricosus* Grav. (*vestalis* Hal.), *Cothonaspis* (*Eucoila*) *rapæ* Westw. From the pupæ of the celery-fly, *Acidia heraclei*, he reared *Hemiteles crassicornis* Grav. (= ? *subzonatus* Grav.) and *Adelura apii* Curtis.

**Anoplura and Mallophaga from Zoological Gardens.**†—Bruce F. Cummings reports on a collection of these ectoparasites from mammals and birds that have died in the Zoological Society's Gardens in London. The collection includes a new species: *Linognathus pithodes* of Anoplura, and two new species of Mallophaga, *Trichodectes hemitragi* and *T. harrisoni*. Many figures are given of the male copulatory apparatus and other distinctive features.

### δ. Arachnida.

**Minute Structure of Sea-spider's Leg-muscle.**‡—H. E. Jordan has studied this in *Anoplodactylus lentris*. It is typical Arthropod muscle, whereas that of *Limulus* is nearer the Vertebrate type. The chief points of difference concern the visible presence of the N disk and the M line, and the wider and more conspicuous character of the Q and J disks in Arthropod as compared with Vertebrate voluntary striped muscle. The sea-spider's leg-muscle is very highly differentiated (as is shown in detail), but the movements are not rapid. There is clear myofibril-tendofibril continuity.

**Ant-like Spiders.**§—Karm Narayan describes the ant-like spiders of the family Attidæ in the Indian Museum collection. They include six new species of Myrmarachne and one of Harmochirus.

**Phagocyte Organs of Scorpion.**‖—E. Pawlowsky describes in *Scorpio maurus* the lymphatic gland on the nerve-chain of the præabdomen, and two lymphoid organs which open on the sides of the lymphatic gland in the diaphragm which separates the cephalothorax

* Ann. Applied Biol., ii. (1915) pp. 158–61.
† Proc. Zool. Soc. London, 1916, pp. 253–95 (24 figs.).
‡ Anat. Record, x. (1916) pp. 493–508 (7 figs.).
§ Records Indian Museum, xi. (1915) pp. 393–406 (1 pl.).
‖ C.R. Soc. Biol. Paris, lxxviii. (1915) pp. 746–50.

from the præ-abdomen. The minute structure and the development of the organs are dealt with.

After an injection of an emulsion of Chinese ink into the general cavity, the particles are found first in the lymphatic gland and in the lymphoid organ. The ink is carried in the plasma of the blood and in the leucocytes. The hyaline leucocytes, the fundamental elements of the lymphatic gland, show a very marked phagocytic capacity, and there is considerable phagocytosis, which the author discusses, in various parts of the body.

### ε. Crustacea.

**Inheritance of Eye-Colour in Gammarus chevreuxi.***—E. W. Sexton and M. B. Wing have made observations on 21,514 specimens of this Amphipod. The normal eye-colour is black, with a superficial reticulation of opaque white pigment. The pigmentation is very variable within limits. Eyes have been observed either partially or entirely lacking in the coloured pigment of the retinular cells, or with either a partial or an entire lack, or else an excess of the opaque white pigment.

A red strain arose as a "sport" in the second generation of off-spring of the first animals captured. No red-eyed forms have been found in many thousands of specimens in natural conditions, nor has the strain been got again from the Pure Black. The red colour is not a sex-limited character; about as many males as females come to maturity. Over 4000 red-eyed individuals were examined.

The inheritance of the coloured pigment of the eye is Mendelian. Black is dormant and Red recessive. The dominants are divided into Pure Black and Impure or Hybrid Black. The Pure Dominants and the Recessives breed true through all generations. An absence or diminution of the white pigment and of the coloured pigment was also studied. The breeding together of animals from different generations gives the same results as regards proportions of colours as the breeding together in the same generation.

**Hepatopancreatic Secretion of Crayfish.**†—Cl. Gautier has studied the properties of this fluid in the fresh-water crayfish, and finds that it has an anti-coagulant efficiency. It is able to hinder the coagulation of the fibrinogen of the plasma (of the horse's blood) by the serum of the same. That implies that the hepatopancreatic secretion blocks the action of the thrombine in the serum.

**Australia Cirripedea.**‡—Hjalmar Broch reports on a number of Cirripedes collected by Mjöberg on the Swedish Scientific Expedition to Australia (1910–13). The collection includes *Balanus mjöbergi* sp. n., growing embedded in a Muriceid colony; *B*. (?) *filigranus* sp. n., which

* Journ. Mar. Biol. Assoc., xi. (1916) pp. 18–50 (1 pl.).
† C.R. Soc. Biol. Paris, lxxviii. (1915) pp. 732–4.
‡ K. Svensk. Vetensk. Handlingar, lii. No. 8 (1916) pp. 3–16 (2 pls. and 2 figs.)

seems to be nearest Darwin's *B. terebratus*, but is perhaps a link between *Balanus* and other genera (*Acasta* and *Pyrgoma*); *Acasta hirsuta* sp. n., fixed to a Plexaurid colony; and *A. antipathidis* sp. n., on an Antipatharian.

**Crustaceans of Colombia.***—A. S. Pearse reports on a collection he made about Santa Marta, on the southern shore of the Caribbean Sea. He discusses the varied habitats—sea, mangrove swamps, streams, forest, and desert. Fiddler-crabs (*Uca*) and Sesarmas were very common among the mangrove roots. The rapid mountain streams contained the amphibious crabs of the genus *Pseudotelphusa*, and the Isopod *Philoscia nitida*. When the streams lose the impetus of their descent they are invaded by hordes of shrimps and prawns. Swamps supported an abundance of Entomostraca and a few fresh-water crabs. The rain-forest showed a large number of Isopods. Some of the streams of the desert along the coast had characteristic Crustacean inhabitants, and *Cœnobita diogenes* wandered about among the sparse vegetation in rocky situations.

Many Crustaceans, like Amphibians, are in process of transition from aquatic to terrestrial life. Every gradation is shown—marine, fresh-water, terrestrial, arboreal. The variety is facilitated by the habit of carrying the eggs about, the omnivorous habits, the protective cuticle, and the plasticity of behaviour in relation to special conditions. Respiration appears to be the chief factor which has kept the majority of Crustaceans in aquatic habitats. In their migrations there have been three main highways: (1) Through the rivers to the land; (2) from ocean directly to land; and (3) from marshes to swamp habitats in fresh-water. The seclusive habits of Crustaceans have doubtless been a great help to them in their landward migration.

## Annulata.

**Study of Cirratulus.**†—F. W. Flattely has studied *Cirratulus (Audouinia) tentaculatus*, a littoral Polychæt with elongate rosy or yellow branchial filaments. It shows marked "thigmotactism," embedding its body so that there is pressure on it from stones. The filaments have no prehensile function, as has been asserted. They are extremely elastic and lengthen out as the worm burrows. Some may stretch for three inches up to the surface of the sand or mud. The heart-body is strongly developed, and may secondarily act as a valve, preventing regurgitation and keeping the filaments turgid. The animal feeds on Algal spores, fragments of decaying Algæ, diatoms and organic débris, which are selected outside the body. Two sensitive ciliated flaps in the mouth are closely apposed when the mouth sucks in food, and prohibit the entrance of any but the smallest food particles. These are wafted backwards by the cilia of the gut epithelium. The filaments certainly do not catch food particles or collect sand particles.

* Proc. U.S. Nat. Museum, xlix. (1915) pp. 531–56 (4 pls.).
† Journ. Mar. Biol. Assoc., xi. (1916) pp. 60–70 (7 figs.).

**New Discodrilid.***—Maurice C. Hall describes *Ceratodrilus thysanosomus* g. et sp. n. from crayfish collected near Salt Lake City. They are not parasitic when young, the intestinal tract showing vegetable detritus and small animals. In the adult stage the teeth are used to break the skin of the host to suck the blood. Ingested muscle fibres were found in the intestine. The prostomium was bilobed, but not sharply, and each lobe was fringed with four or five papillæ on lips. The dental plates are brown, of a roughly crescentic outline, slightly dissimilar, the ventral with six teeth, the dorsal with seven, the teeth being approximately uniform in size. The antero-dorsal border of the head is furnished with a membranous border deeply incised to form four tentaculiform appendages. The first seven trunk segments are furnished with dorsal appendages extending from the lateral border in a pointed band, the number of points usually six, on some segments seven or eight. The unpaired spermatheca is cylindrical to flask-shaped, not bifid. The penis is eversible. The testes are in segments V and VI.

**Notes on Scottish Leeches.**†—John Ritchie, jun., contributes notes on *Protoclepsis tessellata*, *Glossosiphonia complanata*, *G. heteroclita*, *Helobdella stagnalis*, and *Hæmopis sanguisuga*. Of the last-named sixteen specimens were found in August, under one stone in marshy ground, each in a burrow of its own, and doubled up ventrally. At the end of some of the burrows there was a cocoon. The animals were very sluggish, and did not respond to light or touch for some minutes. In the ecdysis the cuticle begins to peel off at the anterior sucker and is turned inside out.

## Nematohelminthes.

**Oxyures of Mammals.**‡—L. G. Seurat has shown that the Oxyuridæ of Mammals belong to two distinct series. The most highly developed representatives of the first series are *Dermatoxys* and *Oxyuris equi*; those of the second series are represented by *Passalurus* Dujardin, and by two new genera (*Syphacia* and *Fusarella*), which require to be established for *Oxyuris obvelata* and *O. vermicularis* respectively. The diagnoses of these two new genera are given.

**Life-history of Spiroptera.**§—L. G. Seurat describes the larvæ of various Nematodes of the Spiroptera group (*Spirocerca sanguinolenta*, *Physocephalus sexalatus*, and *Spirura gastrophila*). He distinguishes the larvæ of the first stage, which come out of the eggs in the abdominal cavity of coprophagous beetles, from the hitherto overlooked free larvæ of the second stage. At the end of the second stage the larvæ become encapsuled, and thus protected pass into the definitive host.

* Proc. U.S. Nat. Museum, xlviii. (1915) pp. 187–93 (3 figs.).
† Glasgow Naturalist, viii. (1916) pp. 8–11.
‡ C.R. Soc. Biol. Paris., lxxix. (1916) pp. 64–8 (3 figs.).
§ C.R. Soc. Biol. Paris, lxxviii. (1915) pp. 561–5 (5 figs.).

**Host of Rictularia proni.***—L. G. Seurat described this Nematode from the stomach of a mongoose (*Herpestes ichneumon*), but he has not re-discovered it there, whereas he finds it abundant in a rat (*Arvicanthis barbarus*). It is nearly related to some other species from Rodents, especially to *R. cristata*. It is one of a series marked by the shortness of the ovijector, the minuteness of the male, the absence of caudal alæ, the presence of sessile genital papillæ, and the inequality of the spicules. In *R. proni* there is an extraordinary difference in size between the male (not over 4·5 mm.), and the female (39·7 mm.).

**Host of Protospirura numidica.**†—L. G. Seurat found this Nematode in the stomach of *Felis ocreata* in Algeria, and compared it with another species (*Protospirura muris*) from the rat (*Mus decumanus*). But the subsequent discovery of *P. numidica* in a rat (*Arvicanthis barbarus*) seems to show that its occurrence in the cat was accidental. A careful comparison of the two species is made, and it is held that *P. muris* shows itself more evolved than *P. numidica*, the points referred to being the greater length of the tail in the male, the presence of small pedunculate pre-anal papillæ, the more anterior position of the vulva, the short and pyriform vestibule like that in other Spiruridæ (*Hartertia* and *Habronema*).

## Platyhelminthes.

**Secondary Echinococcus Infection of the Pericardium.**‡—F. Dévé finds that this is exceptionally due to a bursting of a cyst in the liver or lungs, but that it is almost invariably due to a primary cyst in the heart itself. The primary cyst may break first outwards into the pericardial serous sac; it often bursts subsequently into the interior of the heart.

**North American Frog Lung-flukes.**§—W. W. Cort has made a revision of the Trematodes of the genus *Pneumonœcus* from the lungs of species of *Rana* and *Bufo*. A given host may harbour even in a restricted locality several species, and one species may infest several different hosts. Two different species may occur in the same frog, or even in the same lung. The heaviest infection was in a specimen of *Rana pipiens*, which had twenty full-grown specimens of *Pneumonœcus medioplexus* in one lung and twenty-two in the other. The parasites almost filled the lung cavity, their actual bulk being greater than that of the lung tissue. Species differ greatly in their cuticular spines and reproductive system. Practically nothing is known of the life-history, save that stages of *P. variegatus* have been found in the damsel-fly, *Calopteryx virgo*. The author gives a careful account of six species and a diagnostic key.

* C.R. Soc. Biol. Paris, lxxix. (1916) pp. 146–9 (2 figs.).
† C.R. Soc. Biol. Paris, lxxix. (1916) pp. 143–6 (5 figs.).
‡ C.R. Soc. Biol. Paris, lxxviii. (1915) pp. 734–6.
§ Trans. Amer. Micr. Soc., xxxiv. (1915) pp. 203–40 (3 figs.).

**Contribution to Study of Parasitic Fauna of West of Scotland.*** John Ritchie, jun., has made a study of parasites found within a radius of four miles around Beith in North Ayrshire. His list includes *Trichodina steinii*, an epizoic Infusorian on *Planaria gonocephala*; larval forms of *Polymorphus minutus* encysted in *Gammarus pulex*; the Rotifer *Embata* (*Callidina*) *parasitica* on the appendages of the same Crustacean; the Trematodes *Bunodera luciopercæ* and *Stephanophiala laureata* from the intestine of the trout; *Echinorhynchus truttæ*, *Acanthocephalus lucii*, and *Neorhynchus rutili* from the trout; the Cestode *Schistocephalus gasterostei* in fifteen out of twenty sticklebacks examined: *Gorgodera cygnoides* and *Polystomum integerrimum* from the frog's bladder, *Haplometra cylindracea* from the lung, *Pleurogenes claviger* and *Opisthoglyphe rastellus* from the large intestine; *Acanthocephalus ranæ* from the intestine of frog, toad, and newt; the Trematode *Catatropis verrucosa* from the cæca and adjoining part of the intestine in the widgeon; in the same bird *Polymorphus minutus*, the Acanthocephalan whose larval stages were found in *Gammarus pulex*; *Tænia filamentosa* in the intestine of the mole.

### Incertæ Sedis.

**Larvæ of Lingula and Pelagodiscus.†**—J. H. Ashworth describes the larvæ of *Lingula anatina* and *Pelagodiscus* (*Discinisca*) *atlanticus* collected from the pumped water on board ship on voyages to and from Australia. The larvæ of *Lingula* were obtained from the Red Sea and Indian Ocean, and those of *Pelagodiscus* off Cape Comorin in the Indian Ocean.

The larvæ of *Lingula* have transparent valves without calcareous matter; the posterior and neighbouring lateral margins of the valves are yellowish brown, and in these regions the zone just within the margin is a bright green colour; the mantle margin is usually brownish, especially posteriorly; the basal half of the tentacle, particularly on the dorsal side, and the distal portions of the cirri, are yellowish brown; there is yellow pigment at the postero-lateral margins of the mouth; the "liver"-lobes are lemon-yellow, and near their periphery a small amount of brown pigment is present.

The author describes larvæ with 8–10, 11, 12, 13, and 14 or 15 pairs of cirri; and compares them with those previously described, and with Brooks's larvæ of *Glottidia audebarti*. The evidence available in regard to the southern end of the Red Sea indicates that there is a succession of spawnings extending at least over the period from the beginning of March to the early part of September.

The larvæ of *Pelagodiscus* showed chitinous transparent unequal valves, connected only by muscles and the body-wall. The edges show some yellowish brown colour. The mantle is for the most part colourless, but has a little yellowish brown pigment. Over most of its extent

* Glasgow Naturalist, vii. (1915) pp. 33–42.
† Trans. R. Soc. Edinburgh, li. (1915) pp. 45–69 (2 pls.).

it is very thin and shows numerous gland-cells; in the thickened zone there are, besides gland-cells, more numerous epithelial cells and some muscle-fibres. The chætæ are implanted in this region, which secretes a periostracum. The chætæ are carefully described, as also the peduncle, the median tentacle, the discoidal lophophore, the four pairs of cirri, the pigment-spot or "eye," the statocyst. An account is given of the alimentary system (spherical algæ and a few diatoms were present in the gut) and cœlomoducts or nephridia.

**Phylactolæmatous Polyzoa from Volga Region.***—Nelson Annandale reports on a collection mostly from the Jeruslan river, a tributary of the Volga. All the species are true Palæarctic forms, and only one of them (*Plumatella punctata*) has as yet been found within the limits of the Oriental region. The Phylactolæmatous fauna of the Volga is probably transitionary between that of Europe and that of Central and North-eastern Asia. The author discusses *Fredicella sultana*, sub sp. *jordanica*, and the genus *Plumatella* and its species.

### Rotatoria.

**Sex and Food Conditions in Rotifers.**†—D. D. Whitney has added to his previous work on *Hydatina senta* an experimental study of other five rotifers with regard to the control of sex by food. In pedigreed cultures of *Hydatina senta* a diet of the colourless flagellate Polytoma, which is probably a poor diet, causes female-producing daughters to be produced, whereas a diet of the green flagellate, *Chlamydomonas pulvisculus*, which is probably an optimum food, causes nearly all male-producing daughters to appear. In mass cultures of *Brachionus pala* a scanty diet of miscellaneous green flagellates caused nearly all female-producing females to be produced, whereas a superabundance of this same green diet caused in some experiments 95 p.c. of male-producing daughters to appear. In all cases the results were similar; a scanty diet produced mainly females, but when the rotifers were transferred to a culture-water containing abundant food the percentage of males rose very high.

### Echinoderma.

**Influence of Hypertonic Sea-water on Echinoid Ova.**‡—Arthur Russell Moore finds that the eggs of *Arbacia punctulata* treated with acidulated sea-water show a rhythmicity in sensitiveness to a hypertonic solution. Normally fertilized eggs also show a rhythmical susceptibility to hypertonic sea-water.

The hypertonic treatment may have one of two opposite effects upon

* Trans. R. Soc. Edinburgh, li. (1915) pp. 73–82.
† Journ. Exper. Zool., xx. (1916) pp. 263–95.
‡ Biol. Bulletin, xxviii. (1915), pp. 253–9.

the egg, i.e. beneficial or injurious, depending upon the duration of the treatment, or in other words upon the condition of the egg when treated.

In normal fertilization the spermatozoon starts division and at the same time prevents the production of toxic substances during cleavage or inhibits their action. It is therefore impossible for the hypertonic sea-water to exercise its protective action upon the normally fertilized egg. It can affect it only injuriously. Moore's experiments show that this injurious action is most pronounced just preceding and during cytoplasmic division, and that such action is very slight immediately afterwards.

In the case of artificial parthenogenesis the hypertonic treatment is beneficial. According to Loeb the artificial membrane-formation starts the chemical phenomena which give rise to the process of cell-division and development; but the process is incomplete or abnormal and leads to the disintegration of the egg unless a second treatment is added, usually a treatment with hypertonic sea-water. Since by the membrane formation, chemical or physico-chemical changes induced in the egg are rhythmical, it is intelligible that it should make a difference at which stage of the cycle the treatment with the hypertonic solution is supplied.

**Pacific Holothurians.*** — Hiroshi Ohshima reports on a collection made by the 'Albatross' in the North-western Pacific. It includes forty-six new species, the minute calcareous plates of which are figured. Eleven species are recorded for the first time from the North-western Pacific. The collection contains three new cases of brooding Holothurians, *Cucumaria ijimai*, *C. lamperti*, and *Thyone imbricata*. In some Holothurians, such as *Bathyplotes tizardi*, ova are found attached about the mouth in the male. In some deep sea forms the ova are of large size, those of *Enypniastes eximia* measuring 3–3·5 mm., and those of *Benthodytes gotoi* and *Euphronides depressa* 2·5 mm. in diameter. They exceed the record given by Ludwig for *Benthodytes sanguinolenta* (2–2·2 mm.). A peculiarity not uncommon in Elasipoda is the attachment of the third limb of the intestine to the body-wall along the ventral edge of the right dorsal radial muscle.

## Cœlentera.

**Hydroid Parasitic on Fishes.†** — Ernest Warren describes *Hydrichthys boycei* which grows on the head, fins, sides, and tail of various fishes—a species of *Mugil*, *Ambassis natalensis*, and one of the Glyphidodontidæ. It feeds in greater part, if not wholly, on its host. There is a plate-like hydrorhiza bearing elongated hydranths and branching gonostyles. The plate is capable of budding medusoids directly without the intervention of any obvious gonostyle. In older colonies one or more somewhat massive vertical outgrowths are formed,

* Proc. U.S. Nat. Museum, xlviii. (1915) pp. 213–91 (4 pls.).
† Annals Durban Museum, i. (1916) pp. 172–87 (4 pls. and 1 fig.).

lobed rather than branched, which bear dense clusters of developing medusoids. A hydrocaulus is absent, unless the thick vertical outgrowths and the basal ends of the hydranths and gonostyles are to be so regarded.

The hydrorhiza plate is not composed of a plexus of branching tubes. There is no trace of perisarc. The hydroids are perfectly naked. The whole colony would occasionally contract and extend again. The inner layer of ectoderm on the plate consists of very deep cells which eat into the epidermis of the fish at the growing edge. The inner layer also sends haustorium-like outgrowths into the dermis. Within the two layers of ectoderm in the plate there is an irregular plexus of endodermal canals with only faint traces of mesoglœa. The endoderm of these canals is in direct continuity with the endoderm of the gonostyles or hydranths.

The hydranth is capable of serpentine movement. It has no tentacles and the mouth is usually closed. Round the edge of the mouth there are long nematocysts on a thickened ridge. The endoderm is reddish and its cells are much vacuolated. No captured prey was found in the digestive cavity. The polyp is capable of bending down to the surface of the fish and forcing its widely opened and reflexed mouth into the injured tissues and there tapping the blood vessels. Blood corpuscles are found in the cœlenteron and the endoderm cells can ingest them.

The free-swimming medusoids may arise anywhere on the colony. Their development is typical. Marked features are : (1) the very early appearance of the primordia of the two basal bulbs of the tentacles; and (2) the great increase in the size of the endoderm cells as development proceeds. The medusoids did not survive more than a week in captivity, and the mature stages are unknown. The stages observed suggest *Perigonimus*.

This new Hydroid must be placed near *Hydrichthys mirus*, which Fewkes found on a small fish (*Seriola zonata*), near Newport Marine Laboratory, New England. Fewkes compared the basal plate with the disk of *Velella*, and Warren regards it as conceivable that *Hydrichthys* may be a parasitic Siphonophore. Other Hydroids reported from fishes are *Nudiclava monocanthi* Lloyd, which is doubtfully parasitic, and *Stylactis minoi* Alcock, which seems only a commensal. Warren has described *Aglaophenia parasitica* as sending haustoria into a coralline seaweed, and *Hebella dispolians* as parasitic on *Sertularia bidens*. There is also the problematical *Polypodium hydriforme* reported from the ova of the sturgeon. It is of interest to note the excessive fertility of *Hydrichthys boycei* ; this is characteristic of parasites, and is adaptive to the small chance the embryo has of finding a suitable host. "It is a little curious that the parasite does not spread on the host and destroy it ; but there is a marked tendency among the higher parasites not to cause undue and fatal injuries to their hosts. It would appear that a comparatively short and vigorous life for a colony, in which it rapidly reproduces itself, is more favourable to the species than a prolonged life with a large colony stretching over considerable areas of the fish and threatening the life of the host."

## Porifera.

**Calcareous Sponges of Okhamandal.***—Arthur Dendy reports on a collection of Calcarea made by Mr. James Hornell at Okhamandal in Kattiawar. He has found it necessary to describe as new one species of Sycon (*S. grantioides*) and one of Leucandra (*L. dwarkæensis*), together with a variety of *Leucandra donnani* (var. *tenuiradiata*). More interesting than these new forms, however, are the specimens of *Grantessa hastifera* (Row) and *Heteropia glomerosa* (Bowerbank) which enable the author to add a good deal to our knowledge of these little known species.

**Non-calcareous Sponges from Okhamandal.**†—Arthur Dendy reports on a collection of non-calcareous sponges made by Mr. James Hornell at Okhamandal in Kattiawar It includes fifty-eight species, of which fifteen are new—of which *Tetilla pilula*, *T. barodensis*, *Guitarra indica*, *Psammochela elegans* (for which a new genus is proposed), *Polymastia gemmipara* and *Megalopastas retiaria* may be mentioned as exceptionally interesting forms. The scarcity of true Horny Sponges (Euceratosa) in the collection is remarkable. There is no true bath sponge, and, indeed, only one representative of the family Spongiidæ, viz. the common but useless *Hippospongia clathrata*. All the specimens were from shallow water. A considerable number were growing on the large branching parchment-like tubes of a species of Eunice (probably *E. tubifex*) which seems to be extremely common.

**Sponges Parasitic on Clionidæ.**‡—Nelson Annandale discusses a number of Tetraxonid Sponges which occur parasitically in the burrows of Clionidæ. They include *Coppatias investigatrix* sp. n., a deep-sea form; and *Rhabderemia prolifera* sp. n. Some additional notes are communicated on Indian Clionidæ, including *Cliona kempi*, sp. n.

Clionidæ are liable to be attacked in their burrows by a large number of small sponges belonging to several different families. The majority of these invading species are known to exist also as ordinary encrusting forms, but in a few instances (e.g. that of *Coppatias investigatrix*) the sponge has possibly become a pure parasite. In most cases the invader merely occupies the burrow of the Clionid, which it thrusts before it, but in some instances it is possible that it actually engulfs and digests the proper occupant. Different species of Clionidæ protect themselves against invasion in slightly different ways, but all secrete a horny coat when the invader comes in contact with them. The production of transverse diaphragms in the galleries of the Clionidæ is possibly a means of protection against invading sponges, especially in the case of *C. mucronata*, in which these diaphragms are of an unusually elaborate nature. The production and elaboration of

* Report to Government of Baroda on Marine Zoology of Okhamandal in Kattiawar, pt. ii. (1915) pp. 79–91 (2 pls.).

† Report to Government of Baroda on Marine Zoology of Okhamandal in Kattiawar, pt. ii. (1916) pp. 93–146 (4 pls.).

‡ Records Indian Museum, xi. (1915) pp. 457–78 (1 pl. and 5 figs.).

gemmules in the Clionidæ is perhaps another means of defence against similar enemies, particularly in the case of the deep-sea species *Cliona annulifera* and *Thoosa investigatoris*. The cases of invasion investigated represent only a small proportion of those in which similar phenomena occur.

### Protozoa.

**Endomixis in Paramecium caudatum.*** — Rhoda Erdmann and Lorande L. Woodruff describe the cytological phenomena of the reorganization process in *P. caudatum*, as they previously did in *P. aurelia*. The loss of chromatin in *Paramecium* occurs either by the extension of chromatin bodies (*P. caudatum* and *P. aurelia*); by extension of small granules from the macronucleus (*P. caudatum*); by breaking up of the old macronucleus into two or more large pieces (*P. caudatum* and *P. aurelia*). The result—the total destruction of the individuality of the macronucleus—is the same in each case. Thus in *P. caudatum* there are clearly two methods of macronuclear dissolution in the descending phase of the reorganization process. The reorganization in *P. caudatum* is essentially as in *P. aurelia*, and seems to be of normal periodic occurrence. It is clear that conjugation—the formation of a syncaryon—is not necessary, that an individual *Paramecium* is self-sufficient to reproduce indefinitely without it.

**New Ciliate from Cæcum of Horse.**†—Irwin C. Schumacher describes *Blepharocorys equi* sp. n., a small Ciliate of complex structure, abundant in the cæcum of the horse. The outer covering is stiff, inelastic and non-contractile. There is a slender corkscrew-shaped process projecting from the anterior end, but its use was not discovered. The dorsal surface is more or less convex, the ventral surface slightly concave. There are right and left dorsal plates on an anterior prolongation, the frontal cap. There is no retractile peristome. The mouth is a simple more or less circular opening in the left posterior end of a vestibule near the ventral side. The "œsophagus" is funnel-shaped, ciliated along its dorsal surface. There are cilia on the dorsal plates, in the gullet and anal region. There are membranellæ in the oral and ventral lip regions, but the rest of the surface is naked. The macronucleus is large and heart-shaped: there is a single small micronucleus. The anus is at the posterior end, and near it is a single large contractile vacuole. Locomotion is slow, with frequent turning about on the long axis. The food consists of bacteria and fine fragments of fodder.

**Mitochondria in Trypanosoma lewisi.**‡ — P. G. Shipley has been able to effect vital staining of granulations in this Trypanosome by using Janus green. The granules show the characteristic reactions of mitochondria towards fixing and staining fluids. The question of including them along with the kineto-nucleus as differentiated kinoplasm is discussed.

* Journ. Exper. Zool., xx. (1916) pp. 59–96 (7 pls.).
† Publications Univ. California (Zool.) xvi. (1915) pp. 95–106 (1 pl.).
‡ Anat. Record, x. (1916) pp. 439–45 (1 fig.).

**New Trypanosome.***—C. A. Kofoid and Irene McCulloch describe *Trypanosoma triatomæ* sp. n. from a Hemipteran bug (*Triatoma protractus*) found in the nests of the wood-rat (*Neotoma fuscipes*). The trypanosome occurs in the digestive tract; in the stomach it is found along with blood possibly derived from the wood-rat. The digestive tract of the bug also contains crithidial and trypaniform stages which are probably later forms in the cycle in the Invertebrate host. The trypanosome and crithidial stages are remarkably like the corresponding stages in the cycle of *Schizotrypanum cruzi* Chagas in *Conorhinus megistus* from Brazil, which is the ætiological factor in South American human trypanosomiasis. The authors describe the early stomach phase. or recently ingested trypanosome, the late stomach phase or merozoite, following a probable multiple fission in the epithelial cells of the stomach, a crithidial phase of large size in the stomach, with a "rolled-up" stage suggestive of intracellular multiple fission in the crithidial stage, and a transition series leading to small stout crithidial forms. These probably become small haptomonad forms which are found undergoing binary fission in the rectum. The final trypaniform stages are apparently different from those of *Schizotrypanum* in some minor details. They occur in numbers in both transition and final stages in the rectum. The crithidial stage appears to be more extended in this species than in *Trypanosoma lewisi*, and to run a cycle of larger forms in the stomach than in the rectum. The structure of the so-called "kinetonucleus" supports the interpretation that it is in reality the parabasal body.

**Intestinal Protozoan Parasites in Turkey.**†—Theobald Smith describes a Protozoon which occurred sparsely in the mucous membrane of the intestinal villi of the turkey. He did not find it possible to determine whether it belongs to one or the other of the two well-known species of avian Coccidia (*Eimeria avium* and *Isospora lacazei*), or whether it is a foreign aberrant type which fails to survive in the accidental host. The relative smallness of the schizonts, which measure 10 microns, and of the merozoites (the only one that could be found and measured being $5\mu$ in length) points to the second view.

**Klossiella in Guinea-pig.**‡—Louise Pearce has found in the kidneys of twelve apparently normal guinea-pigs (from Pennsylvania and New Jersey) a parasite that closely resembles *Klossiella muris*, described by Smith and Johnson, and the renal parasite of two West African guinea-pigs, described by Seidelin. The number of sporozoites is from eight to twelve, usually eight. A ring form which is unlike any of the stages in either the sporoblast or schizogonic cycle is tentatively interpreted as a male element or microgamete. A tubular form which resembles the glomerular body of *K. muris* may be the schizogonic phase of the parasite.

* Publications Univ. California (Zool.) xvi. (1916) pp. 113–26 (2 pls.).
† Journ. Exper. Med., xxiii. (1916) pp. 293–300 (1 pl.).
‡ Journ. Exper. Med., xxiii. (1916) pp. 431–42 (8 pls.).

**Notes on Tintinnoina.***—C. A. Kofoid publishes some notes on these minute Protozoa of the high seas which build for themselves beautiful vase-shaped or bell-shaped houses or loricæ of delicate texture, elaborate patterns, and wide range of form. In 1873 Haeckel figured the mitre-like *Dictyocysta tiara*, which has not been seen since in spite of much searching. Kofoid gives reasons for believing that Haeckel's figure represents a large lorica of *D. lepida*, with ten instead of the usual eight fenestræ, which had shrunken in the aboral region as the result of desiccation. He figures a lorica in which the aboral contraction due to shrinkage was observed as the formalin in the preserved sea-water containing the specimens was allowed to evaporate.

Kofoid establishes *Petalotricha entzi* sp. n. on the strength of two figures given to Entz of an Adriatic form which he mistakenly referred to *P. ampulla ampulla*. The new species is wholly distinct, and is peculiar in the submerging of the oral shelf by the thickened wall of the nuchal region, as also in the fluted oral shelf and ridged bowl.

* Publications Univ. California (Zool.) xvi. (1915) pp. 63–9 (8 figs.).

# BOTANY.

## GENERAL,

### Including the Anatomy and Physiology of Seed Plants.

### Cytology,

#### Including Cell-contents.

**Chondriome in Algæ and Fungi.***—A. Guilliermond publishes the third and final paper dealing with his investigations as to the functions of the mitochondrias. The author now states the general results and conclusions of his work, which are as follows:—1. The existence of a chondriome having been demonstrated in numerous and widely differing groups of Fungi, it appears safe to conclude that it is found in all Fungi. 2. In the Algæ it has not been possible to discover a chondriome in either the Conjugateæ or in the Confervaceæ, but it has been proved that the unique chloroplasts which characterize these groups are not homologous with the chloroplasts of the Phanerogams, but are rather to be regarded as highly differentiated mitochondria. In the Florideæ and the Phæophyceæ an ordinary chondriome is present, but the chloroplasts are similar to those of higher plants. 3. The chondriome is absent in the Cyanophyceæ, where its functions appear to belong to the nucleus. 4. The function of the chondriome has been clearly proved in the Fungi; the chondriocontes give rise to vesicles which are absolutely analogous to those which in higher plants produce starch, and it seems probable that in this case they have the power of producing glycogen, fats, etc.

The author concludes that the presence of the chondriome in so large a number of and in such widely different types of plant and animal cells proves it to be "a constituent element of a cell, indispensable to its function and of the same order as the nucleus." Like the nucleus it can only reproduce itself by division, but it lacks the power of the latter to transmit its characters from one generation to another.

### Structure and Development.

#### Vegetative.

**Anatomy of Crotalaria.**†—A. Lacoste publishes a comparative description of the anatomical characters of *Crotalaria*, and suggests a new classification of this genus based upon its anatomy in place of the

* Rev. Gén. Bot., xxvii. (1915) pp. 297–315 (1 pl. and 3 figs.).
† Rev. Gén. Bot., xxvii. (1915) pp. 10–21 (2 figs.).

present method of classification, which rests upon ill-defined morphological differences.

The two main groups of the new classification depend upon the arrangement of the vascular bundles in the stem and leaf-stalk; in the first and largest group these bundles cross one another, while in the second and smaller group they tend to arrange themselves in a more or less complete circle. These two main groups are each subdivided into two groups, in one of which stomata are found on both surfaces of the leaf, and in the other are confined to one surface. Further subdivisions are based upon the position of hairs and papillæ, the structure of the palisade-tissue, the presence of stipules, etc.

## General.

**Fasciation in Maize Kernels.*** — T. K. Wolfe publishes a paper dealing with the relative weight of hybrid and pure seed produced by crossing different varieties of maize. In the present experiment the seed-parent was a variety of yellow dent and the pollen-parent a variety of white dent. Two kernels were selected from the experimental ear, differing from the remaining kernels in having a slight ridge of demarcation, on one side of which the colour was yellow and on the other paler yellow. Examination showed that each of these kernels contained two embryos, both of which were successfully germinated and brought to maturity; they were then self-pollinated by hand, and the four ears thus produced (i.e. one from each embryo) were reserved for further experiment. All four ears showed Mendelian splitting, and the average ratio of yellow to white kernels was 3·61 : 1; none of the kernels possessed two embryos like their parents.

The author intends to continue the experiments, and to publish an account of the results obtained during the present season.

**Hybridation between Juglans and Corylus.†**—L. Daniel publishes a brief description of an anomalous fruit borne by a walnut tree. The shell (i.e. the endocarp) was wrinkled, but was of a conical shape and entire. The kernel was exactly like that of a hazel-nut, except for its mode of attachment which was similar to that of the walnut; around the kernel were the fragments of tissue characteristic of the hazel-nut, and at the base were numerous ridges and grooves. The seed was successfully germinated and produced a seedling entirely similar to that of the hazel, but owing to an accident the young plant died, so that its further development could not be traced. The author believes that this is a case of natural but unusual hybridization between the walnut and the hazel, since the branches of the tree bearing this fruit were closely intertwined with those of a hazel. The behaviour in germination recalls the results obtained by J. Daniel with certain species of beans.

* Amer. Nat., l. (1916) pp. 306–9 (3 figs.).
† Rev. Gén. Bot., xxviii. (1916) pp. 11–14 (12 figs.).

## CRYPTOGAMS.

### Pteridophyta.

(By A. Gepp, M.A. F.L.S.)

**Prothallia of Ophioglossum vulgatum.***—Norma E. Pfeiffer gives an account of the prothallia of *Ophioglossum vulgatum*. These were first discovered in 1904, in the Thuringian Forest by Bruchmann, who during five months succeeded in isolating 70 young examples. A similar find is now recorded near Chicago. Where the grass has been burned off, the mature *Ophioglossum* plants are very evident; and where the ground is very shaded, *Selaginella apus* and *Aneura pinguis* occur; for the spot is low and wet, and after inundation may harbour *Riccia fluitans*. The spikes shed their spores in July; and it is suggested that spore-germination depends on inundation. The prothallia so far found have sporophytes attached to them; and from the age of the sporophytes it is evident that the attachment has persisted for some seasons since fertilization occurred. The appearance of the prothallia agrees with Bruchmann's description. The surface is uneven and brownish; the end is rounded or even tuberous; the long axis is vertical. Several sex organs are dotted over the surface; production of them was probably continued after fertilization. The central region contains stores of starch, and is free from fungi; but fungi abound in four to six subcortical layers. Reproduction of *Ophioglossum* by vegetative method is far more common than by gametophyte formation.

**Acrosticheæ and their Position in the Fern System.**†—G. Schumann writes on the position of the Acrosticheæ in the Fern system, and is of opinion that they branch off from forms in which the sporangia follows the course of the veins. The proof of this was obtained by a study of early stages of development in which the sporangia first appear above the veins. A further proof is seen in the frequent transition-forms, in which also the sporangia follow the course of the veins. Since the sporangia have repeatedly spread over from the veins on to the parenchyma, the Acrosticheæ must be broken up and allotted different positions in the Fern system. *Acrostichum aureum* stands quite isolated both as to sporophyte and gametophyte. Perhaps it should be placed near *Pteris*. *Stenochlæna* is allied to *Blechnum*. The Leptochileæ with divided lamina branch off from *Dryopteris*, subgenus *Meniscium*; those with undivided lamina probably from species of *Polypodium*. *Stenosemia* may be left for the present in *Polybotrya*. The green sporangia in *Stenosemia* and *Leptochilus cuspidatus* show that the stem of the sporangium, and perhaps also the wall-cells, belong to the tissue of the leaf. Further details must be sought in the original paper.

* Bot. Gaz., lxi. (1916) pp. 518–22 (figs.).

† Flora, cviii. (1915) pp. 201–60 (41 figs.). See also Bot. Centralbl., cxxxi. (1916) p. 624.

**Genus Platycerium.***—H. v. Straszewski writes on the morphology, anatomy and physiology of the genus *Platycerium*. The gametophyte shows great similarity with that of Cyatheaceæ; forked prothallia, many-celled glandular hairs, and divided cap-cells in the antheridium all point to Cyatheaceæ. The cells of the root-cortex show a similar thickening to the cells of the roots of Orchidaceæ; they are capable of absorbing water through the cortex. Also the intercellular spaces of the basal fronds ("Mantelblatter" and "Mantelnischenblatter") contain water. The "Mantelblatter" when young show a negative geotropic curvature, which is corrected later by epinasty. This epinasty obliges the leaves to lie flat on the substratum. The ground tissue of the "Mantelblatter" consists only of spongy parenchyma. The hypoderm is a non-mucilaginous water-tissue. The "Mantelnischenblatter" and "Mantelblatter" are phylogenetically older than the "Laubblatter." The "Mantelblatter" have developed from the "Mantelnischenblatter." *Platycerium* does not belong to the Acrosticheæ, and has nothing to do with *Cheiropleura*. Its best position is among Polypodiaceæ. The author divides Platycerieæ into three geographical groups, and considers the grouping of Fée and Diels to be wrong. The three groups are: (1) South American region with one species (*P. andinum*); (2) the African region with five species; and (3) the Asiatic and Australian region with eleven species. The author goes into the question of leaf-dimorphism with much detail.

**New Varieties of Nephrolepis.**†—R. C. Benedict discusses the origin of new varieties of *Nephrolepis* by orthogenetic saltation. The variations are discontinuous and large, and they also occur along a few limited lines. 1. The genus is tropical; and nearly all its species tend to vary under cultivation, but *N. exaltata* in particular has through its variety *bostoniensis* been especially prolific of new forms; at least some sixty named horticultural forms have been recorded, and probably as many more remain unnamed. The great majority of these have arisen from bud-sports; for the reproduction is almost exclusively vegetative. The present paper is limited to the more pronounced lines of progressive variation. 2. Cultural conditions favour the appearance and preservation of variations. 3. The variations are of two sorts—progressive and regressive. 4. Progressive variations have followed three main lines, viz. increased division of leaf, or ruffling of pinnæ, or dwarfing. Also dichotomy may occur. 5. Progressive increase in division has gone on for five vegetative generations; ruffling for three; dwarfing for three. 6. Dwarfing is of two sorts: first, brachyotic or unilinear; and second, normal in all directions. Also more than one type of division-sport is found. 7. Progressive increase in leaf division and progressive dwarfing may always be expected until the possible limit has been reached. 8. Regressive variations rarely if ever show complete return to their parent forms or to var. *bostoniensis*. 9. The indicated coefficient

* Flora, cviii. (1915) pp. 271–310 (42 figs.). See also Bot. Centralbl., cxxxii. (1916) p. 39.

† Bull. Torrey Bot. Club, xliii. (1916) pp. 207-34 (6 pls.).

of variation for progressive variation is very low, probably between one in one million and one in one thousand. Regressive variation is much more common. 10. The variations are all discrete or discontinuous, not proceeding by imperceptible differences. 11. The progressive variations in their differences actually parallel the differences existing between many wild species of ferns and flowering plants. 12. The main difference between these variations and those shown by wild forms lies in the fact that these horticultural forms do not possess adaptability to natural conditions. In most cases, with the variation has come decreased vigour of growth. 13. The causes of these variations are undetermined; they seem to be the response to internal stimulation. Improved cultural conditions do not appear to cause the variations, but are the means of preserving forms which, under wild conditions, would be eliminated by natural selection. Several forms are figured, and a genealogical chart is provided.

**Polypodium Species of Tropical America.***—W. R. Maxon publishes a further contribution to his study of tropical American ferns. Three groups of *Polypodium* have been widely misunderstood in the past, namely, *P. trichomanoides*, *P. furfuraceum*, *P. squamatum*, and their respective groups of allies. He gives a synopsis of each group, with a key to the species, photographs of several type-plants, descriptions of eleven new species, and critical notes on the rest. He describes also five other new species of *Polypodium*, and supplies critical notes on species of *Nothalæna* about which there has been much confusion.

## Bryophyta.

(By A. Gepp.)

**Gemma-formation in Marchantia.†**—J. Doposcheg-Uhlar writes on the formation of external and internal gemmiferous cupules on the male receptacles of *Marchantia*. He says that in the *Marchantia geminata* of Java the antheridial receptacle may pass from the generative condition to the vegetative; single lobes (rays) cease to form antheridia, continue a thallus-like growth at the apex, and produce gemmiferous cupules. These cupules may arise in a normal manner superficially at the vegetative apex. Gemmæ are also found inside the transformed thallose portion of the lobe (ray), as well as in the old unchanged portion, in old empty antheridial cavities, and also in stomata. The origin of these gemmæ lies either at the base of these hollow spaces or below them. Above these inner gemmiferous cavities are formed "stifte," which probably by separating and opening become structures

* Contrib. U.S. National Herb. Washington, xvii. (1916) pp. 541–608 (12 pls.).
† Flora, cviii. (1915) pp. 261–70 (14 figs.). See also Bot. Centralbl., cxxxi. (1916) pp. 592–3.

resembling normal cupules, and thus allow the escape of the gemmæ. Finally, the author discusses shortly the outer and inner conditions which bring about this phenomenon. He emphasizes the point that here, as in numerous other plant-groups, the relation of organic to inorganic substances may play a part. The possibilities which could bring about such a disturbance in nutrition are indicated.

**Fruit-pedicel of Hepaticæ.***—Ch. Douin, who in recent years has called attention to the importance of the sporogonium, and especially of the pedicel, as distinctive characters in certain groups or genera of hepaticæ, shows that it is necessary to use the results with discretion, and discusses errors which have been made by other bryologists. K. Müller, for instance, has described the characteristic structure of the pedicel of *Cephalozia fluitans*, but unfortunately selected an abnormal pedicel for the purpose. Müller also figured wrongly the transverse section of the pedicel of *Lepidozia silvatica*. Douin now figures several sections from a type-plant which show the correct structure. Douin also calls attention to the fact that if tranverse sections of the *living* pedicel of Cephaloziellaceæ are cut, four files of large cells are seen; but if the material is fixed in Fleming's solution, dehydrated and hardened, before being cut, the sections are found to contain four files of large outer cells, and four files of small inner cells. These latter become torn in sections of *living* material; and, further, during the rapid growth of the pedicel they also become ruptured and are replaced by a long intercellular meatus.

**New Principles of Systematic Bryology.**†—L. Loeske lays down the following principles of systematic bryology: a greater regard to the conditions of life, to the biology; a rejection of the principle, hitherto maintained, of the greater importance of the sporophyte; the equal importance of both generations; also a rejection of the firmly held principle that anatomical characteristics are of greater importance than morphological. Systematic unities, including species, are abstractions, although, in the fixed and but slightly variable species, conception and object may correspond very well. There are no characteristics which can be laid down as "specific," but every group of mosses, down to the species and forms, must be studied and classified according to its particular idiosyncrasy. Critical valuation must be made of all attainable data for the improvement of the systematic arrangement, which knows no finality. Natural relationship must be brought more prominently forward than has hitherto been the case. Systematic arrangement is a scientific result which is always capable of improvement. On these principles is based the forthcoming work on the Laubmoose Europas (published by Max Lande, Berlin-Schöneberg).

* Rev. Gén. Bot., xxviii. (1916) pp. 129-32 (1 pl.).
† Hedwigia, liv. (1914) pp. 210-16. See also Bot. Centralbl., cxxxii. (1916) p. 99.

## Thallophyta.

### Algæ.

(By Mrs. Ethel S. Gepp.)

**Colourless Rhizopodial Chrysomonad.***—A. Pascher found epiphytic on *Œdogonium* grown under culture, a colourless rhizopodial Chrysomonad of the type of *Lagynion*. He calls it *Heterolagynion Œdogonii*. The principal points in connexion with it are as follows: The great similarity of the shells between this colourless organism and the genus of Chrysomonads; the fact that Chrysomonads may throw out temporary and also permanent rhizopodia; that among the Flagellates as well as among the rhizopodial forms of the Chrysomonads apochromatic types appear; that the present new organism produces leucosin, like the other apochromatic and euchromatic Chrysomonads. The new find is a proof of a closer relation between Rhizopods and Flagellates, and of the erroneous position of many or all known Rhizopods. This also is another indication that a "rhizopodial form" need not be at all characteristic of "primitive organization," but that the "rhizopodial form" is only the morphological expression of a mostly secondary adaptation to a certain mode of nutrition.

**Halosphæra.**†—A. Pascher has made a study of material of *Halosphæra*, collected in sixty-five localities in the Northern hemisphere, and in seventeen in the Southern. The results are as follows: 1. *Halosphæra* occurs in all oceans, without forming geographical varieties. 2. Its northerly distribution is established up to 72° 45′ N. 3. The membrane consists of two portions closed together like a nutshell, composed principally of pectine, and containing also silica. 4. During the growth of the cells new halves of the membrane are formed inside the original ones, the old halves crack off like caps, and remain sometimes adhering for a time to the cells. This is shown in Gran's figures. 5. The numerous chromatophores, which not infrequently are connected together by differentiated bridges of protoplasm, often contain a large quantity of carotin, and take a blue colour with hydrochloric acid. The quantity of carotin varies greatly. 6. The products of assimilation consist of fats and oils, never starch. There occurs also in larger or smaller balls a brightly glittering body, the chemical nature of which is unknown. 7. The nucleus, often eccentrically placed, shows in division numerous chromosomes. Its chemical composition varies from that of the Chlorophyceæ nucleus. 8. As regards reproduction the following facts were established: (*a*) The formation of 8–128 globular 2-shelled aplanosphores, which set free the mother-cells by a dehiscence of the shells; (*b*) the formation of a large resting-cell, which however does not fill up all the mother-cell;

* Ber. Deutsch. Bot. Gesell., xxx. (1912) pp. 152–8 (1 pl.). See also Bot. Centralbl., cxxxii. (1916) p. 30.

† Ber. Deutsch. Bot. Gesell., xxxiii. (1915) pp. 488–92. See also Bot. Centralbl., cxxxii. (1916) pp. 31–2.

its thick membrane also consists of two unequal shells; (c) probably swarmspores exist in *Halosphæra*. Many burst *Halosphæra* cells were found from which a bubble was issuing, and in which were many (twenty-eight and more) small protoplasts. It was possible to determine the method of their formation. After a series of successive nuclear divisions the nuclei wandered into the peripheral protoplasm of the cell, thus making numerous splits in the protoplasm, until finally every nucleus was surrounded by a portion of protoplasm. This is similar to the formation of swarmspores in many algæ. These small protoplasts represent the swarmspores of *Halosphæra*, for nearly all of them possessed two fine unequal cilia. Sometimes only one cilium was to be seen. Whether the other was not present or simply not visible the author cannot say. These swarmspores possessed mostly two, but sometimes one or several, of the small *Halosphæra* chromatophores; the author believes he detected a red eye-spot. It is probable that the swarmspores are very metabolic or amœboid. Differences in form occurred which could not be attributed to methods of fixing. The author considers that the swarmspores described and figured by Schmitz do not belong to *Halosphæra*.

On the strength of morphological peculiarities the author excludes *Halosphæra* from Chlorophyceæ and places it with Heterokontæ. Further, he establishes a relationship between it and *Botrydiopsis* Borzi, going so far as to suggest that they are generically the same, and that *Botrydiopsis* should be sunk into *Halosphæra*. The connexion between *Eremosphæra* and *Halosphæra* is quite false. A synopsis of Heterococcales is given.

In an addendum the author describes an alga, *Monodus amicimei*, found with *Halosphæra*.

**Microspora.*** — K. Meyer writes on the genus *Microspora*. The species can be divided into two distinct groups. 1. The first, which includes *M. amœna* and *M. floccosa*, has a barred chromatophore and has lost the power of producing zoospores with four cilia. Under unfavourable conditions akinetes may be developed which represent the resting stage. 2. The second group, represented by *M. Willeana*, has a chromatophore of roundish disk-shape connected in strings like a rosary. Zoospores with four cilia occur. *Microspora* Thur. and *Microspora* (Thur.) Lagerheim are not synonymous. The author followed the entire life-cycle of *M. amœna* on material from the neighbourhood of Moscow during several years, and describes it.

**Relation of Schizogonium to Prasiola.†** — F. Brand has made a thorough study of *Schizogonium* and *Prasiola*. As a result he gives a new and amplified diagnosis of *P. crispa* (Lightf.) Wille, with synonyms: viz. *Schizogonium* (Kütz.) Gay; *P. crispa* (Lightf.) Menegh. incl. *Schizogonium* and *Hormidium* Kütz. ex p. He distinguishes six forms,

* Ber. Deutsch. Bot. Gesell., xxxi. (1913) pp. 441–8 (1 pl.). See also Bot. Centralbl., cxxxii. (1916) p. 30.

† Hedwigia, liv. (1914) pp. 295–310 (1 fig.). See also Bot. Centralbl. cxxxii. (1916) p. 29.

and gives their synonyms. The first form, f. *simplex*, is not the most common, but is the one from which all the others spring and is the only one which is found in an unmixed state by itself. All the forms have the same cell structure and react in the same manner to coloration. They therefore belong genetically together. Under favourable circumstances the above alga possesses unlimited growth and is perennial. Active reproductive cells were not seen. Spontaneous cutting-off of one or many-celled portions of thallus occurs often. The reproductive akinetæ need more study.

**Bavarian Desmids.***—R. Gistl writes on the Desmid flora of the Bavarian upland swamps. For the five districts examined, 115 species are recorded, of which forty are new to Bavaria. One of these is new to science, *Nectrium conicum*; and a new variety is described for *N. oblongum*. Details of size are given for each species, based on original measurements. As regards the biology and methods of culture, nothing new is given. Certain species, such as *Cosmarium compressum*, which remained dry for eighteen months, seem to be insensitive to outward conditions. Four species sustained life through six months in a dry state, *Cosmarium sphagnicolum*, *Euastrum scrobiculare*, *Micrasterias truncata*, and *Staurastrum margaritaceum*. *Closterium pronum* and *Tetmemorus lævis* are resistant to cold. Both survived being frozen in ice. It is therefore possible that those species, for which zygospores are unknown, do not possess them because they are capable of resisting drought and frost.

**Diatoms of Brazil.**†—C. Zimmerman continues his studies on the diatoms of Brazil. In the present note he records 121 species belonging to forty-seven genera.

**Fossil Algæ.**‡—C. D. Walcott writes on the Pre-Cambrian Algonkian Algal Flora. The first part contains general considerations on continental conditions during Algonkian time; the origin of Algonkian limestones; the deposition of limestone through the agency of algæ, magnesian limestones, and the algal flora. In the latter chapter a comparison is made between recent blue-green algæ deposits and those of Algonkian time. Special attention is directed to the resemblance of some of the fossils and the so-called lake-balls. A large number of new genera and species are described and illustrated. In one of these, *Camasia*, chains of microscopic cells were obtained by treatment with hydrochloric acid. The chains resemble Cyanophyceæ. The one species described comes from the Newland limestone, Meagher County, Montana, and is unusually interesting owing to its resemblance to the deposit made by the Cyanophyceæ in the fresh-water lakes of New York, Michigan, and elsewhere.

* Beitr. z. Kenntn. d. Desmidiaceenflora der Bayerischen Hochmoore. München (1914) 60 pp. (4 pls.). See also Bot. Centralbl., cxxxi. (1916) p. 653.
† Broteria, xiii. (1915). See also Bot. Centralbl., cxxxi. (1916) p. 567.
‡ Smithson. Miscell. Coll., lxiv. (1914) pt. 2, pp. 77–156 (pls. 4–23). See also Bot. Centralbl., cxxxi. (1916) pp. 651–3.

**Influence of Nutritive Salts on the Colouring of Oscillarieæ.*** W. Magnus and B. Schindler describe their experiments on the influence of nutrition upon the coloration of Oscillarieæ. The work of other writers is discussed on the effect of light as affecting the colour. Brunnthaler alone suggests that *Glœothece* may be influenced by food-substances. This suggestion is taken up by the present authors, who chose *Phormidium autumnale* Gom. and *Oscillatoria formosa* Bory as the subjects for their investigation. The result of their work is as follows. The gradual multiplication and the stronger growth of the filaments cause the nutritive substances to be devoured, till finally the necessary salts are no longer present. If the cells do not continue to grow and divide, the continued assimilation inside the cell would cause the physiological balance of the filaments to be gravely disturbed by the accumulation of carbohydrates. If, however, they continue to grow while lacking proper nutrition, they must degenerate and die. The ecology of the yellow coloration would lie herein: that the colouring material which assists assimilation becomes less and less, and at last quite disappears. A resting-stage sets in, since all absorption of nutrition ceases. It is always possible that with a similar minimum of nutritive substances the coloration of shaded cultures would also be delayed, because with largely decreased assimilation the disturbances of metabolism caused by lack of nutritive substances would be less strongly marked. The change of colour observed by the authors stands in marked contrast to the chromatic adaptation observed by Gaidukov. While in that case the usefulness to the plant lies in a change of colour which favours assimilation, the experiments of the authors show that the change in colour is designed to lower the degree of assimilation. The change of colour is useful to the plant, because only in that way can great disturbances of metabolism be avoided.

**Mucilaginous Glands in Certain Laminariaceæ.**†—C. Sauvageau writes on certain glands in species of Laminariaceæ which do not possess mucilaginous canals. These were described by Okamura for *Undaria Peterseniana*, by Miyabe for *U. pinnatifida*, and by Yendo for *U. undarioides*. Yendo calls them mucilaginous glands, and describes their structure and contents. In the present paper they are now recorded in monostromatic plantlets of *Alaria esculenta* grown under culture. The glands were not present on all the plantlets, but most of them showed the glands when they reached a length of 400–500 $\mu$. The glands are either isolated or in groups of two or three, of the same size as the neighbouring cells or larger, because they have lost the power of division. They are really reservoirs of fucosan. The ordinary cells of the plant contain some chromatophores and numerous globules of fucosan, less than 1 $\mu$ in size. The glands appear more refringent and almost colourless, because besides the chromatophores and the small fucosan globules, they are as it were stuffed with larger and very refringent globules, measuring 2–4 $\mu$. Formol contracts their contents

* Ber. Deutsch. Bot. Gesell., xxx. (1912) pp. 314–20. See also Bot. Centralbl., cxxxi. (1916) p. 566.

† C.R.. Acad. Sci. Paris, clxii. (1916) pp. 921–4.

into an amorphous pale brownish mass. They correspond well with the mucilage glands of Yendo. The author describes the effect of certain re-agents on the contents of these cells. The plantlets, arising from cultures which were started on February 8, were damaged by heat towards the end of May, and very few of the half-dead plants showed the fucosan reservoirs. In the living as in the dead tissue, the cell-contents had become transformed into a deep brown, compact, contracted mass, resembling a tannic composition already recorded by the author for several Phæosporeæ. These brown cells are doubtless the transformed fucosan reservoirs, and seem to indicate that the fucosan in large globules is not utilized by the plant. Whether this transformation is however normal or caused by adverse conditions the author cannot say.

The reservoirs of fucosan, and later on the cells with brown contents, are situated in the monostromatic portion of the lamina. The basal distromatic portion showed none of them. Wille has recorded for *A. esculenta* a deep mechanical tissue for the storing of fucosan, but does not mention any element comparable with these mucilage glands. Unless these have been overlooked, they are therefore confined to the young plantlets: while in *Undaria pinnatifida* they are only recorded by Yendo on plants with a length exceeding 7·5 mm. The author's efforts to examine small plants of *Alaria* grown under natural conditions at Roscoff were defeated by the condition of the sea, but he is disposed to believe that young sporophylls of *Alaria* harbour similar organs, beneath the epidermis.

The mucilage glands of *Undaria* are therefore fucosan reservoirs like those of *A. esculenta*, and although the possible transformation of fucosan into mucilage may not be proved, notwithstanding the identical action of certain colouring reagents, still the presence of these particular cells in precisely the four species which have no muciferous canals, is distinctly worthy of attention.

## Fungi.

(By A. Lorrain Smith, F.L.S.)

**Phytophthora infestans.*** — F. D. Kern and C. R. Orton have investigated an attack on tomatoes by this fungus in Pennsylvania. It has already been recorded on tomato plants, but is uncommon and not usually very important economically. On this occasion it caused serious and wide-spread damage. The weather had been unfavourable for the setting of the fruit, and it is suggested that this might have encouraged the growth of the fungus.

**Marine Fungi Imperfecti.†**— G. K. Sutherland has investigated a number of these fungi in the course of his work on marine Ascomycetes. He describes several Hyphomycetes: *Cladosporium algarum*, the

* Phytopathology, vi. (1916) pp. 284–7 (2 figs.).
† New Phytologist, xv. (1916) pp. 35–48.

conidia of which germinated freely in sea-water; *Fusidium maritimum*, saprophytic on *Laminaria* and *Pelvetia*, both on fronds collected above high-tide mark, and on decaying thalli periodically submerged; *Monosporium maritimum*, also found on decaying *Laminaria* fronds; *Sporotrichum maritimum*, on the same habitat; *Cercospora salina*, on various sea-weeds in widely distant localities; *Macrosporium laminarianum*, *Alternaria maritima*, and *Epidochium maritimum*, all saprophytic on *Laminaria* fronds. The fungi were collected from the Orkneys, Ayrshire, and Dorset coasts.

**Peridermium Harknessii and Cronartium quercinum.***—E. P. Meinecke has instituted a research to determine the relation between *Peridermium Harknessii* and *P. cerebrum*, and with the alternate form *Cronartium quercinum*.

Both the above species of *Peridermium* form galls on pine-trees, and though the identity of the two has yet to be proved by inoculation, there is strong probability that they are the same. It is very common on *Pinus attenuata* and several other species, and can be transmitted from pine to pine by infection with æcidiospores, probably through the agency of insects.

*Cronartium quercinum* overwinters on *Quercus aquifolia*; new uredospores form in spring around the old dead sori and these infect the new leaves. Heterœcism in both the above fungi is facultative.

**Thelephoraceæ of North America.**†—E. A. Burt discusses the genera *Exobasidium*, *Tremellodendron*, *Eichleriella* and *Sebacina*. The three latter genera possess cruciately divided basidia.

The species *Exobasidium Vaccinii* is a parasite on the leaves, etc., of various genera and species of Ericaceæ; it is common and of wide distribution; the leaves show a red spot on the upper surface over against the white fructification beneath. Several other species are described. The species of *Tremellodendron* are indigenous to North America. The fructifications have the general habit of branched or simple Clavarias and spring up on the ground in deep woods during wet weather in summer and autumn; seven species are described.

*Eichleriella* is described as a *Stereum* or *Cyphella* with a tremellaceous hymenium. *Sebacina*, which occurs as incrustations, is represented in North America by fourteen species.

**Rhizoctonia crocorum and R. Solani.**‡—B. M. Duggar has given an historical account of the occurrence of these two destructive parasites. He has examined both species and concludes that *Rhizoctonia* on crocus, alfalfa and other hosts may be included in one morphological species; there is no perfect stage of the fungus to give a decision as to its affinity. There seem to be distinct forms or races within the species.

*R. Solani* grows on many dicotyledonous plants, and is known so

* Phytopathology, vi. (1916) pp. 225–40 (2 figs.).

† Ann. Miss. Bot. Gard., ii. (1916) pp. 627–58 (1 pl.).; and pp. 731–66 (12 figs. and 2 pls.).

‡ Ann. Miss. Bot. Gard., ii. (1916) pp. 403–58 (9 figs.).

far on one monocotyledonous host only, *Asparagus Sprengeri*. It can be distinguished from *R. crocorum* by the form of the mycelium, sclerotia, etc., and it is readily culturable. The perfect stage is *Corticium vagum*. An extensive bibliography accompanies the text.

**Agaricaceæ.***—W. A. Murrill has just issued Part 5, vol. ix., of the North American Flora which includes a consideration of several genera belonging to his subtribe Lepiotanæ. There is a synoptic key to the genera and also to the species, which are fully described. The genera have nearly all received new or ancient names, which has necessitated a multitude of new combinations. Many new species in the different genera are also described for the first time, most of them so far from one locality only. The Flora includes that of the West Indian Islands.

**Studies in Polyporaceæ.**†—L. O. Overholts publishes a short account of the family, its history, microscopic characters, his methods of working and examining the plants, and a detailed account of a number of species belonging to *Polyporus*, and *Fomes*, paying particular attention to the hyphæ, spores, etc.

**Fungi Exotici.**‡—W. B. Grove publishes a large number of fungi new to science that have been determined, mostly by E. M. Wakefield. They were collected in Tropical Africa, Nigeria, Uganda, etc., and in India, etc. One of them, *Polyporus Shoreæ*, is suspected of being the cause of a serious disease called "Sal"; the effect on the trees on which it is parasitic is somewhat similar to that of *Trametes Pini*.

**Hydnochæte and some Rare Fungi.**§—C. G. Lloyd does not regard *Hydnochæte* as a good genus, and would prefer to classify its four species as a section of *Hymenochæte*—it is really a tubercular *Hymenochæte* or a *Grandinia* with setæ.

Among the rare species Lloyd describes are *Radulum Ballonii*, a pileate form with hard and woody texture; *Mycocitrus aurantium*, a giant member of the Hypocreaceæ, grows on living branches without apparently being parasitic; *Hydnangium Ravenelii*, received from Alabama, grows on the surface of the ground, while other species of the genus are hypogæal.

**New or Noteworthy Fungi.**‖—A series of species new to science or new to this country are published by W. B. Grove, with descriptions in all cases. They belong mostly to the Fungi Imperfecti, and five are new species, including one Pyrenomycete, *Sordaria coronifera*, collected on dung at Earlswood near Birmingham.

* North Amer. Flora, ix. pt. 5 (1916) pp. 297–374.
† Ann. Miss. Bot. Gard., ii. (1916) pp. 667–724 (3 pls. and 8 figs.).
‡ Kew Bull., No. 3 (1916) pp. 71–7 (1 pl. and 3 figs).
§ Mycol. Notes, Cincinnati, Ohio, No. 41 (1916) pp. 557–72 (1 pl. and 6 figs.).
‖ Journ. Bot., liv. (1916) pp. 185–93.

**Soil Fungi.***—F. C. Werkenthin gives an historical account of the study of soil fungi, and gives a résumé of the results obtained by different workers. His own investigations comprised the examination of three different kinds of soil taken at various seasons from (1) a cotton-field: (2) from flower beds of the University greenhouse; and (3) from the University campus which had lain undisturbed for twenty years.

In his summary of results he states that:—Up to the depth of four inches, soil fungi are fairly uniformly distributed. In deeper regions, below four inches, no viable fungous spores seem to be present. There does not seem to be any variation of fungi in regard to cultivated or virgin soil. The climate seems to have great influence on the flora of soil fungi. Species of *Aspergillus* are the dominant soil fungi of the South; *Penicillii*, so frequently found in northern States, are rare in Texas soils; the Mucorales are not as abundant in southern soils as they are in colder climates. Pathogenic fungi, such as *Fusarium*, live in the soil as saprophytes throughout the winter.

**Diseases of Plants.**†—J. J. Taubenhaus had his attention directed to a serious disease of the garden Columbine, which on examination proved to be attached by the fungus *Sclerotinia libertiana*. The disease is characterized by a general wilting of the leaves, the stems are covered with a webwork of white fungus strands, and sclerotia are lodged in the hollow centres. Cultures were made and the ascospore stage was formed. The sclerotia may pass the winter in manure.

F. L. Stevens and Alvah Peterson ‡ describe some fungi that cause disease on strawberries: *Sphæronemella Fragariæ* sp. n., attacks the berries and the affected spots become tan-coloured. The berry begins to shrivel and in a few days is destroyed. The disease is not only injurious in itself, but it is generally followed by more destructive fungi, such as *Rhizopus*, which gain entrance through the lesions. Another fungus, *Patinella Fragariæ* sp. n., which forms sporodochia, is at first visible as small sunken discoloured spots on the green or ripe strawberry, and develops rapidly. Spores are produced in enormous numbers, and with these cultures were made and fresh berries were successively inoculated. Other diseases, such as *Botrytis cinerea*, *Sphæropsis malorum*, and *Rhizopus nigricans*, were noted as causing trouble.

A *Sclerotinia* § disease of *Citrus* called "cottony rot" attacks the twigs of oranges and lemons in the orchard and the fruit of the lemon in the packing house. Clayton O. Smith has proved by his cultures and inoculations that it is probably identical with *Sclerotinia libertiana*. The hyphæ of the vegetative stage are able to enter and destroy a perfectly sound lemon without any abrasion of the skin, but attempts to infect with spores were unsuccessful, except at the stem and blossom ends.

* Phytopathology, vi. (1916) pp. 241–53.
† Phytopathology, vi. (1916) pp. 254–7 (2 figs.).
‡ Phytopathology, vi. (1916) pp. 258–66 (1 pl.).
§ Phytopathology, vi. (1916) pp. 268–78 (5 figs.).

**Phoma Disease of Lavender.***—W. B. Brierley publishes an account of this new species, *Phoma lavendulæ*, and of the various culture experiments to test its pathogenicity. On nutrient media the fungus produces hyaline thin-walled pycnospores, thin-walled conidia, which become thick-walled and brown, and thick-walled brown chlamydospores. On the host the mycelium rammifies through all the tissues and produces *pycnidia* below the epidermis. Conidial formation is absent from the normal life-cycle, but chlamydospores are occasionally formed.

## Mycetozoa.

(By A. Lorrain Smith, F.L.S.)

**Formation of Sporangia in the Genus Stemonitis.**†—A. E. Hilton describes the development of sporangia in this genus from the plasmodium to the spore stages. The material which he examined was found on an old stump, covering in patches the blackened remains of an old leathery fungus which grew on it; it was then in the milk-white plasmodium stage and in a semi-fluid condition, though in cushion-like form. In about a quarter of an hour after collecting, the cushions were covered with bubble-like hemispheres of uniform size, due to dividing up of the plasm into smaller masses. The first observations had been made at 12 noon; by 4 p.m. the area covered by the hemispheres was contracting; they were growing taller and assuming a somewhat conical shape, while the lower portions of the mass were becoming columnar. In another half hour black stalks were visible at the centres of the columns. At 6 p.m. the sporangia were nearly half an inch in height, and at 10 p.m. they had attained their ultimate shape, though still of a light brown or buff colour. By 8 a.m. of the following day they were nearly black; and by 8 p.m. they were a dark purplish brown. Immediately before the actual formation of spores, the numerous nuclei in the plasm greatly increase in number, each nucleus becoming the centre of an individual spore.

* Kew Bull., No. 5 (1916) p. 113-31 (2 pls. and 9 figs.).
† Journ. Quekett Micr. Club, xiii. (April, 1916) 6 pp. (1 pl.).

## Schizophyta.

### Schizomycetes.

**Bacillus fallax and Gas Gangrene.***—M. Weinberg and P. Séguin have made further investigation with regard to the anaerobic organism that they have previously described as *Bacillus fallax*, and find that it is frequently present in war wounds. In four cases out of 125 it possibly played an important rôle in the evolution of gas gangrene, though in these cases its appearance was associated with the presence of other gas-producing organisms. In the first case, *B. fallax* was associated with *B. œdematiens* and the Vibrion septique; in the second case with *B. perfringens*; in the third case with *B. perfringens*, *B. sporogenes*, and the Vibrion septique; and in the fourth case with *B. œdematiens*, *B. perfringens*, the Vibrion septique, and other organisms. In one of the cases in which a perfringens septicæmia yielded to serological treatment, the patient succumbed to a brancho-pneumonia caused by the *B. fallax*.

**New Species of Botryosporium.**†—A Sartory has isolated a new species of *Botryosporium*, which he has called *B. corda*, from the intestinal tube of the field-cricket (*Gryllus campestris*). The fungus grows strongly upon licorice-wood, upon which it forms beautiful masses, at first white, then pink, and finally poppy-red. It divides a certain number of times with great regularity, so that the branches fall very evenly, forming a sort of culture "en cascade." The spores are oval in shape, and measure some 6 $\mu$ in length by 3·5 $\mu$ in breadth. This species resembles *B. pyramidale*, except in point of colour. The medium of election is licorice-wood, but carrot and Sabouraud's medium are also excellent. The red colour appears quickly on agar, and gelatin is liquefied in twelve days. Milk is coagulated in fifteen days, the casein being precipitated and then partly peptonized. The fungus ferments glucose and maltose, but is without action on saccharose, lactose, and galactose. The pigment secreted is soluble in ethyl-alcohol, chloroform, benzene, toluene, carbon bisulphide, and xylol. It is insoluble in methyl-alcohol, amyl-alcohol, and water. Acids and alkalies turn the pigment a deep yellow colour. Spectroscopic examination of chloroform solutions of the pigment reveal a slight absorption-band between the D and the E lines. The organism was isolated on seven occasions, and appears to be a simple saprophyte.

**Etiology of Scarlet Fever.**‡—W. Mair gives a further description of a diplococcus isolated from the throats of scarlet fever patients, and considered by him to be the causal organism of the disease. In its most typical form, in cultures on serum agar or on serum broth, the *Diplococcus scarletinæ* is an oval or oat-shaped coccus measuring about

* C.R. Soc. Biol. Paris, lxxix. (1916) pp. 581–3.
† C.R. Soc. Biol. Paris, lxxix. (1916) pp. 516–7.
‡ Journ. Path. and Bact., xx. (1916) pp. 366–83.

$1 \cdot 2\ \mu$ by $0 \cdot 6\ \mu$. It is arranged for the most part in pairs, end to end, and both ends of each member of the pair are distinctly pointed. Short chains up to about ten pairs occur in serum broth. It is non-motile, and retains the stain in Gram's method. Capsules cannot as a rule be demonstrated in cultures, but occasionally when stained by Hiss' copper-sulphate method, capsules can be made out. The diplococcus ferments glucose, mannose, galactose, lævulose, maltose, lactose, saccharose, raffinose, and dextrine. Inulin and salicin are also fermented, but with some strains longer time is required. Dulcite and sorbite are not attacked. Mannite is slowly fermented by some strains, but not by all. A slight degree of acidity is produced in arabinose and xylose, none in isodulcite. Glycol is slowly fermented, but neither glycerol nor erythrite are attacked. The organism gives a positive reaction with Neufeld's bile test, thus resembling the pneumococcus, while its pathogenicity for mice is of a low order, as compared with the latter organism. Complement fixation tests appear to support the theory of the causal relationship of the organism to the disease. The author is of opinion that the disease may exist an an epizootic among mice.

# MICROSCOPY.

## B. Technique.*

### (1) Collecting Objects, including Culture Processes.

**Whey Medium for the Gonococcus.**†—T. Watabiki, after long experience with the cultivation of the gonococcus, maintains that blood-agar and blood-bouillon are the most suitable media for growing gonococci. When, however, blood cannot easily be obtained for the purpose, whey-agar or whey-bouillon may be used as substitutes. 100 c.cm. fresh milk is warmed to 60° C., and 5 p.c. acetic acid added drop by drop, the milk being shaken to cause precipitation of the casein; it is then filtered through filter-paper. To the filtrate 10 p.c. caustic soda solution is added up to the point of slight alkalinity to litmus-paper, and then 9·3 grm. nutrose and 0·2 grm. urea (previously dissolved in a little boiling water). The clear colourless fluid is then sterilized by keeping at 60° C. for thirty minutes every day for three days. Next, this sterilized fluid is well mixed with melted agar medium (2·5 p.c.) at 45° C., in the proportion of about 1 part of fluid to 2 parts of agar, and then plates of slopes are prepared as required. It is necessary that the fluid should not be heated above 70° C. The author has frequently noticed unsatisfactory results with fluid heated at a higher temperature. Urea is not necessary, though its presence seems favourable. For the precipitation of casein the amount of acetic acid is not constant, as different samples of milk undoubtedly vary in quality. About the same percentage of urea was added as that in normal urine (20 to 25 grm. urea in 1000 c.cm. urine).

**Experimental Typhoid Septicæmia by Means of Bile Cultures.**‡ M. le Fevre de Arric has devised a method of exalting the virulence of a virulent typhoid bacilli by means of bile cultures. The original culture employed was of such a low degree of virulence that 10 c.cm. of a 24-hour broth culture injected under the skin of a 400-grm. guinea-pig did not provoke any symptoms. When, however, the cultures were made in sterilized ox-bile, and after forty-eight hours injected into guinea-pigs of similar weight, the animals succumbed in less

* This subdivision contains (1) Collecting Objects, including Culture Processes; (2) Preparing Objects; (3) Cutting, including Imbedding and Microtomes; (4) Staining and Injecting; (5) Mounting, including slides, preservative fluids, etc.; (6) Miscellaneous.

† Journ. Path. and Bact., xx. (1916) pp. 408-9.

‡ C.R. Soc. Biol. Paris, lxxix. (1916) pp. 602-4.

than twenty hours with hyperpyrexial symptoms. The administration of a similar quantity of sterile bile to a control animal only produced a certain amount of temporary ill-health. The lethal effect can also be produced by the simultaneous inoculation of 5 c.cm. bile and 5 c.cm. ordinary bouillon culture. Virulent typhoid bacilli were recovered from the peritoneal cavity, the heart-blood and the bile of the animals dead of the infection, and on growing these organisms again in the presence of bile, their virulence for guinea-pigs was further enhanced.

**Culture Media Prepared with Digested and Diluted Serum.*** A. Distaso advocates the following methods of preparing digested serum media for general use in the laboratory :—

*Liquid Medium.*—One volume of ox- or sheep-serum is diluted with an equal volume of tap-water, and is sterilized for fifteen minutes at a temperature of 120° C. The liquid is then digested for twenty-four hours at 60° C. with a chloroform extract of pig's pancreas. The digested liquid, which should be of a clear amber colour, is passed through the filter, distributed in tubes, and re-sterilized. The various sugars may be added in order to produce the corresponding sugar media.

*Solid Media.*—Three or four grm. of agar is added to 100 c.cm. tap-water and sterilized. An equal volume of the liquid medium above described is then added, and the whole re-sterilized. The resulting medium is transparent and of an amber colour. It is admirably suited for culturing the tubercle bacillus, and for demonstrating the pigment produced by *Bacillus proteus* and other organisms. It is also very suitable for growing anaerobic cultures of such organisms as *B. perfringens*, *B. sporogenes*, and *B. putrificus*.

The media described are cheap, easy to prepare, and induce more luxuriant cultures of micro-organisms than those obtained by the use of ordinary pepton broth and agar media.

**Note on Dysentery from the Dardanelles.†** — L. Tribondeau and M. Fichet have investigated the fauna and flora of a series of 217 cases invalided from the Dardanelles for dysentery. In forty-eight cases the examination was positive, ten being cases of amœbic dysentery, and the remaining thirty-eight being of bacillary origin. Of these latter, twenty-three were due to the bacillus of Shiga, two to the bacillus of Hiss, and thirteen apparently to bacilli of the Morgan group. The cases in which the Morgan group organisms were isolated were typical, with blood and mucus in the stools, and in which no other pathogenic organism was demonstrated. Agglutination reactions with the patients' sera were, however, negative, and the organism was not recoverable by means of blood cultures.

**Effects of Sensitized Vaccines.‡** — S. Kakehi has completed an elaborate study of the effects of sensitized vaccines as opposed to those

* C.R. Soc. Biol. Paris, lxxix. (1916) pp. 599–601.
† Ann. Inst. Pasteur, xxx. (1916) pp. 357–62.
‡ Journ. Path. and Bact., xx. (1916) pp. 410–41.

of ordinary vaccines. The organism used in his experiments was the *Bacillus pseudo-tuberculosis rodentium* Pfeiffer, and the research animal was the rabbit. The following were found to be the effects upon the rabbit of the killed vaccine sensitized by Besredka's method, as compared with those of non-sensitized :

1. The sensitized vaccine has one slight advantage, in that the increase of temperature in injected animals is a little lower on the average than that produced by the non-sensitized, not only after the first injection, but also after succeeding injections.

2. The animals can generally bear the various series of injections of the sensitized vaccine with much less loss of weight than when the non-sensitized is used, so that the former appears to be less toxic, although the number of animals which died of injection is not sufficient to decide this point.

3. As to the degree of immunity obtained by the injection of each kind of vaccine, there is no appreciable difference, for they both give about the same degree of resistance against various lethal doses when the animals are compared ten days after the last injection of vaccine.

The production of antibodies in the serum, testable by agglutination and complement fixation, is much less with the sensitized than with non-sensitized vaccine under the same conditions. Thus the estimation of these antibodies in vitro does not show the actual degree of immunity given by the former, as compared with the latter.

**Advantage of using a Broth containing Trypsin in making Blood Cultures.***—S. R. Douglas and L. Colebrook's experiments have confirmed the findings of Wright and his fellow-workers, which showed that when by mixture with trypsin the antitryptic power of blood is neutralized, the blood loses its power of clotting and also its antibacterial properties. These are precisely the changes which it is desirable to bring about when attempting to cultivate pathogenic micro-organisms from the circulating blood. A series of blood cultures performed in duplicate with trypsin broth and simple broth has shown that the employment of trypsin in that procedure is clearly advantageous, the organisms having been in some cases recovered only in the trypsin tubes, while in the other cases they were recovered earlier and more frequently in these than in the control tubes. It is probable that this method favours the cultivation of any microbe that may be present in the blood, and not especially one particular organism or group of organisms, as in the case of bile media. Staphylococci, streptococci, paratyphoid bacilli, anthrax, were readily isolated from blood by the use of trypsin broth. In order to be sure of neutralizing the antitryptic power of the inoculated blood, it is recommended to employ broth containing not less than 5 p.c. of trypsin solution (compound solution of trypsin Allen and Hanbury), and to add not more than 1 c.cm. of blood to each 5-c.cm. tube of such a broth. When a supply of broth is not at hand, or the blood has to be sent by post to a laboratory, undiluted trypsin solution may conveniently be mixed with the blood specimen, immediately on its withdrawal from the

* Lancet, July 29, 1916, pp. 180–3.

vein, say in the proportion of 1 of trypsin to 4 of blood. Subsequently this unclotted blood should be planted into broth-tubes for incubation, or where this cannot be done, the blood may be incubated without dilution, and the growth of organisms sought for in the plasma.

**Cultivation of Tissues from Amphibians.***—J. C. Johnson chiefly used *Diemyctylus torosus* in his experiments, and thus summarizes his results :—1. Nerve-growth observations indicate an out-pulling of nerve-fibre, rather than an outpushing. Progress outward is by means of pseudopod-like processes. 2. Gill-like processes appear on tissues from the head region of the body. 3. Flat drops of serum produced better results than deep rounded drops, causing tissue to be up against the solid cover-slip ; they afford also better conditions for study with an oil-immersion lens. 4. A common Stender dish with moist cotton in the bottom offers a good way for cultivating a large quantity of tissue. 5. At other points than the tips of outgrowths, bacterial infection at first increases activity. 6. Diemyctylous tissues thrive best when washed in Ringer's solution, and transferred about every two days to a fresh medium. 7. Increased toxin condition of serum and tissue causes decreased heart activity ; the heart-beat increases in proportion to the increase of temperature. 8. Gill-like outgrowths can be moved in any desired direction by changing the position of a hot pin applied to the surface of the cover-slip. 9. Connective tissue was kept in a healthy growing condition for forty-one days, when it was accidentally killed.

### (2) Preparing Objects.

**Method for Preparing the Scales of Eels and Other Fishes for Mounting.** — A. Gardolfi Hornyold, Aquario Vasio de Gama, Lisbon, says it is by no means easy to prepare perfectly cleaned scales for microscopic examination, as they are easily damaged. Having during the last year worked on the determination of the age of the eel by the scales, it was found necessary to find a method enabling him to prepare a large number of scales rapidly and without damage. The scales are obtained by scraping the skin with a sharp scalpel, and are then placed in weak alcohol, or simply in water, to macerate for twenty-four to forty-eight hours. The scales are then centrifugalized and the water or alcohol poured off and fresh water is substituted ; after repeating this operation three or four times one obtains perfectly cleaned scales, which can be selected with the dissecting Microscope. A simple hand-driven centrifuge as used by doctors for urinary examination, etc., is suitable for this work ; though of course an electrically driven centrifuge is more convenient. The author found no difficulty in preparing the scales of a dozen eels in a morning by this method. This method gives equally good results with the scales of other fishes, such as the sprat, sardine, etc.

* Univ. California Publications, xvi. (1915) pp. 55–62 (2 figs.).

### (4) Staining and Injecting.

**Staining Tubercle Bacilli.***—H. Biersy describes the following new procedure for staining tubercle bacilli in sputum:—1. To 1 vol. of sputum add 2 vols. of distilled water, if the sputum be thin; but if thick, 5 vols. of distilled water. Then add hypochlorite soda 1 drop plus 20 to 40 drops of 1 p.c. caustic soda to 5 c.cm. of sputum. 2. Heat the mixture at a temperature not exceeding 37°. Add soda solution drop by drop until the mixture is quite homogeneous. 3. Pour the mixture into a test tube with rubber stopper (1 vol. plus 1 vol. of distilled water). Mix. Add drop by drop acetic acid until the reaction is feebly acid to litmus. Centrifuge for ten minutes; decant off supernatant and reserve it. Spread the deposit on slides. Add acetic acid to the decanted fluid until a precipitate forms. Centrifuge, and then spread the new deposit on slides. Make films of the deposit on slides; dry, fix, and stain by Ziehl-Neelsen method.

**Staining with Alizarin.†**—G. Colosi says the following method gives good results. The material used was chiefly Invertebrates. The material was fixed and embedded in paraffin. The sections were bathed for a few seconds in a 1 p.c. aqueous solution of acetate of uranium. After washing in running water, the sections were treated with 1 to 200 aqueous sulphate of soda and alizarin. After a few seconds the preparations were washed, and, having been passed through up-graded alcohols, were mounted. The medium does not seem to be of importance.

**New Technique for Staining Sections with Hæmalum-eosin.‡** L. Tribendeau recommends the following method of preparing and employing solutions of hæmalum-eosin:

*Preparation of Mother-solution.*—Place 1 grm. of nitrate of silver crystals in a clean corked flask of some 150 c.cm. capacity, and which has been rinsed previously with distilled water; add 100 c.cm. of distilled water and dissolve by shaking. Into this solution empty as quickly as possible 50 c.cm. of solution of potash (oxide of potash pure 10 grm., distilled water 100 c.cm.), cork the flask immediately, and shake it for some seconds while holding it by the neck and the cork. Allow it to stand for about one minute, and then decant off the cloudy and brownish supernatant fluid down to the level of the heavy precipitate of oxide of silver which collects at the bottom of the flask. Add 150 c.cm. of distilled water to this precipitate, cork, shake again, set aside for a minute, and re-decant as above. Repeat the whole process three or four times.

Dissolve 2·5 grm. of hæmatoxylin (française) in 50 c.cm. of absolute ethyl-alcohol. Add this solution to the oxide of silver precipitate and empty the mixture into a long-necked flask, place in the water-bath, and shake from time to time until the alcohol starts to boil.

* Comptes Rendus, clxiii. (1916) pp. 110-2.
† Monitore Zool. Ital., xxvi. (1915) pp. 248-51.
‡ C.R. Soc. Biol. Paris, lxxix. (1916) pp. 288-9.

The solution has then acquired a deep orange colour. Filter through filter-paper. This mother-solution is employed by adding 1 vol. to 20 vols. of alum solution (potash alum 50 grm., distilled water 1000 c.cm). The mixture immediately turns violet, and should be used as soon as possible.

*Method of Employment.*—The sections having been freed from paraffin by means of xylol, alcohol, and distilled water are treated with the hæmalum solution for two minutes (15 minutes if the chromatin is specially required to be differentiated). Wash in tap-water, and counter-stain with a solution of 1 grm. of eosin (alcoholic française) in 100 c.cm. absolute alcohol (one or two minutes). Wash and dehydrate in the usual manner and mount.

### (5) Mounting, including Slides, Preservative Fluids, etc.

**Arsenious Acid-glycerin-gelatin ("Arsenious Jelly") Method of Preserving and Mounting Pathological Specimens with their Natural Colours.***—S. Delépine describes the following method for mounting specimens :—

*A. Fixing Solution.*—Formal (commercial) 40 p.c. solution, 100 c.cm.; water, 900 c.cm. To which may be added, sulphate of soda, 20 grm.

The specimens are left in this solution for from three days to two weeks, according to thickness. A piece of tissue ½ in. thick is sufficiently fixed and hardened in two days. (For a time the author used a larger proportion of formaldehyde, 5 p.c. and even 8 p.c., but found that for most purposes a 4 p.c. solution was sufficient.)

*B. Alcohol* (80 to 90 p.c.).—The specimens are left in this fluid until the colour has returned as nearly as possible to its original tint. A few hours are generally sufficient to obtain a satisfactory and permanent superficial effect.

*C. Arsenious Acid-glycerin Fluid.*—Arsenious acid solution (made by boiling an excess of arsenious acid in water for two hours, and allowing the fluid to stand for twelve hours), 400 c.cm.; pure glycerin, 600 c.cm.

The specimens are transferred from the alcohol to this solution, where they must be kept for one or two days at least. They may without serious disadvantage remain in it for two or three weeks, if the solution does not cause marked shrinkage.

*D. Arsenious Acid-glycerin Jelly* (formula for about 8 litres).—1. Coignet's gelatin (Gold label), 425 grm.; arsenious acid, saturated water solution (see *C*), 1500 c.cm. The dry gelatin, thoroughly cleansed, is added to the hot arsenious acid solution, in which it should be entirely dissolved in less than ½ hour. 2. Hot arsenious acid jelly (see 1), 1925 c.cm. (say 2000); pure glycerin (hot), 5760 c.cm. (say 5800).

The two are mixed together and allowed to cool to about 20° C., then the white of six eggs and their broken shells are added and mixed thoroughly with the mass. The mixture is brought again to nearly boiling-point to coagulate the albumin, and is maintained at this temperature for two hours. The hot fluid is strained through flannel

* Museums Journal, xiii. (1914) pp. 322–5.

and then filtered through filter-paper, the temperature of the fluid being kept at about 50° C. This takes from one to three days.

At the present price of glycerin and formaldehyde, 1 litre of this medium costs 3*s*. 6*d*. This medium is absolutely transparent, and when set does not melt at the highest summer temperature.

This arsenious acid-glycerin-gelatin (or shortly, "arsenious jelly") does not act as an ordinary mounting medium only, but has the property of preserving colour better than the potassium-acetate-glycerin fluid or other preserving fluids used in the Kaiserling and allied methods. It can be used to mount specimens in jars, but the chief object in devising this solid medium was to find a method by which specimens, and more especially flat sections, could be fixed to glass plates so as to do away with the distortion produced by the uneven walls of museum jars. The use of glass plates has also the great advantage of diminishing cost and reducing the space occupied by specimens.

**Mounting of Specimens on Glass Plates.***—For many years the method which S. Delépine used consisted in mounting sections, or parts of organs, not exceeding a quarter to half an inch in thickness, in arsenious acid glycerin between two glass plates, a paper or a glass border being used during mounting to hold the jelly. The excess of gelatin having been removed, the edges were covered with adhesive india-rubber plaster, over which a continuous layer of lead foil was glued. The preparation was then finished by gluing a cloth band over the lead foil, or by mounting in a wooden frame.

Very thin sections mounted in this way are very permanent. Some in the author's collection were over twenty-five years old, but thick sections are frequently a source of trouble after a few years, owing to the contraction of the gelatin and the penetration of air under the glass. To avoid this difficulty, the idea of enclosing the specimen and medium in an air-tight space between fixed plates was abandoned. The author now mounts the specimen against the glass plate through which it is to be seen. It is embedded in jelly, which is covered at the back with a second glass plate smaller than the front plate. The back plate is also used to apply a backing of suitable colour, generally white, grey, or black. In the case of thick sections, whole organs, animals, etc., nothing is done to close the sides, which are protected by resting the front plate upon the rim of a box made of plaster of Paris, glass, or metal.

The little glycerin which oozes out of the medium is absorbed by some porous paper, plaster of Paris, or felt, which is placed between the back plate and the bottom of the box; this padding also supports the back plate. Under these conditions the back plate follows the gelatin when it shrinks, and air does not penetrate under the glass. Specimens of almost any size can be prepared by this method. As to stability, the author had specimens mounted seventeen years ago which were still perfect, and had retained their colour without any appreciable change. They had been exposed to light for long periods.

To facilitate manipulations and reduce the amount of time needed

† Museums Journal, xiii. (1914) pp. 327–9 (1 fig.).

to mount specimens by this method, the author had devised certain appliances which were described (fig. 33).

*Levelling Table.*—A large glass table (with levelling screws) with tall legs, to allow the inspection of the specimen from below whilst it is being mounted.

*Heavy Steel Bars* of suitable shape and thickness, to form the sides of a mould for the gelatin medium. The inner side and one end of each of these bars are polished, and cut at such an angle that they come in perfect apposition with the ends of other bars; the gelatin sets rapidly on coming in contact with the cold metal.

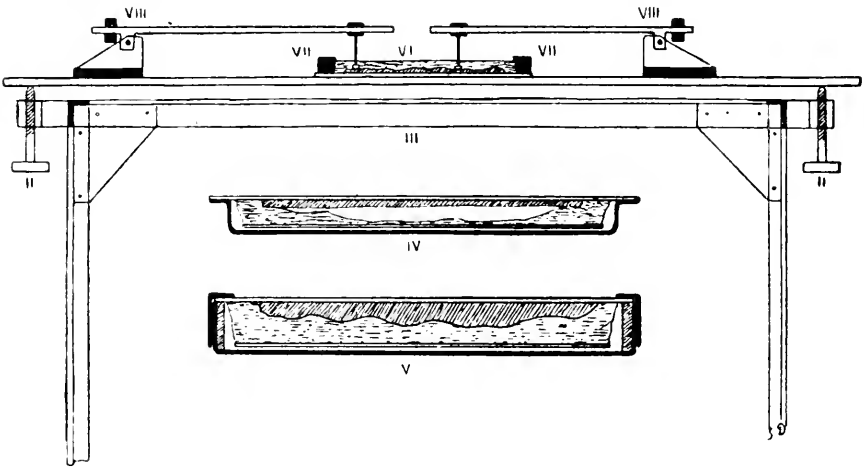



Fig. 33.—I. Glass table seen in section. II. Levelling screws (third not seen). (There are three more supporting screws.) III. Iron framework of levelling table. IV. Sections of preparation mounted in aluminium dish with flange (arsenious jelly between two glass plates indicated by faint horizontal shading). V. Section of preparation mounted in aluminium box. VI. Section of specimen in process of mounting. The specimen is laid on the glass plate, through which it is to be seen, and it is covered with arsenious jelly. VII. Heavy steel bars used to hold the jelly while it is setting. VIII. Counter-balanced levers used to press the specimen against the glass plate by means of rods sliding on the levers.

*Moulds* for making plaster of Paris boxes, which need not be described.

*Aluminium Dishes and Boxes.*—In order to save the time required for the preparation of plaster of Paris dishes, the author had various kinds of earthenware and glass dishes made, but these were heavy, clumsy, and expensive. Finally, a form of aluminium dish was adopted, which has answered the purpose very well. The first type has a flat flange, to which the top glass plate is fixed by suitable binding. To simplify still further the work of mounting, boxes were made to the lid of which the front glass is fixed; the box is closed like an ordinary

box. Whether plaster of Paris or metal cases are used, the gelatin must not come in contact with the sides of the dishes. The tools necessary to make these boxes have proved fairly expensive, but the boxes themselves can be obtained at a comparatively small cost.

**Preparation and Mounting of Microscopic Objects.*** — H. C. Whitfield says that in cutting the tissues for fixing purposes, small pieces are essential, in order that the tissues may be quickly permeated with the fixing fluid. The chief fixing agents are osmic acid, chromo-acetic acid, picro-acetic acid, formalin, and alcohol. The first-named is most efficient for small subjects, but is barred in many cases owing to expense. The cheapest of the three is chromo-acetic acid, which may be washed out in water afterwards, thereby preventing shrinkage. The drawback to picro-acetic acid is that it necessitates the use of alcohol for removing the fixing fluid from the specimen, consequently the risk of shrinkage of the cells is much greater in this method of treatment. The use of osmic acid is often followed by blackening of the cell-contents.

Chromo-acetic formula :—Chr. acid, 1 grain ; glac. acetic, 2·25 c.cm. ; water, 300 c.cm.

There are many cases where fixing is not required, but in all instances the material needs treatment, so that it may be preserved in such a state that the cells retain their normal shape and do not undergo any degeneration. This may be accomplished by treatment with 50 p.c. alcohol, followed successively by 75 p.c., 90 p.c., and absolute, at periods of six or seven hours. By this means the material becomes impregnated with the spirit without causing shrinkage. They may then be kept in spirit indefinitely, and used as required.

*Section Cutting.*—This may be performed in various ways : by hand with or without a microtome, or by a mechanically controlled section cutter. The free-hand cutting is quite satisfactory in many cases for sections for cursory examination, but if a really good specimen for permanent use is required the use of a microtome is advised. In the author's own work the two which he made use of were Cole's hand section cutter, and the Cambridge Rocking Microtome. Both of these necessitate the use of embedding material. In the former, fresh carrot is the most suitable, while the latter requires a much longer preparation, as the subject must be treated for paraffin infiltration. This will be described later in Ribbon Section Cutting and Staining. In cutting the sections a well-sharpened razor must be used. The author usually got the cutler to grind the razor, a stiff hollow-ground pattern, and then set it himself on a hone. This is done by a slicing action, rubbing the edge of the razor against the hone, as it were taking a slice from the stone. The operation is easily completed in ten minutes or so. The razor must then be well stropped in such a manner that the *back* of the razor never leaves the strop. On placing the object in the carrot, a slicing action is preferable to a planing action, as there is a tendency to tear the tissues with the latter method.

* Proc. Photomicrographic Soc., v. (1916) pp. 43–52 (3 figs.).

*Staining Sections.*—Apart from the preparation of sections for exhibition purposes, staining should never be resorted to without some definite end in view. By subjecting tissues to the actions of stains the tissues are more easily discerned and differentiated; therefore we should use the stain most suited to the purpose. Stains may be used generally to attack (1) the ground tissue; (2) the nuclear structure. The behaviour of various tissues in the presence of aqueous or alcoholic solutions of the various dyes is of great advantage to the biologist. In Botany, when an aqueous stain is used, both hard and soft structures are stained, but the addition of an alcoholic stain of different colour has the property of discharging the aqueous stain from the softer tissues, while the aqueous stain is still retained in the harder structure. The following list of stains and their action on the various structures in plants may be useful:—

*Cellulose*:—

Iodine—yellow.
Iodine + $H_2SO_4$—blue.
Chlor. zinc iodine—blue-violet.
Hæmatoxylin—blue.
Carmin plus mordant—red.

It is also stained by meth. blue and other aniline dyes.

*Lignified Cell-walls*:—

Iodine—strong yellow.
An. sulphate—bright yellow.
Carbolic-hydrochloric acid—green (in presence of light).

Carmin and hæmatoxylin have no action, but it is readily stained by aniline colours.

*Corky or Cuticularized Walls*:—

Stain with aniline colours.
Carmin and hæmatox.—no action.

*Chitin*:—

(i) Meth. blue (acid).
(ii) Erythrosin.

With regard to the stains, the author generally made up his own from the powder form, as they worked out much cheaper in the end by this means. He had some really good and efficient stains made from the old penny packets of aniline dyes, especially an aniline acid green made some four years ago. The stains he generally employed were as follows:—

A { Saffranin, aqueous.
  { Aniline green (acid), alcoholic.
B { Carmin borax.
  { Acid an. green.
C { Fuchsin, aqueous.
  { Meth. green, alcoholic.
D { Hæmatoxylin, acid (Ehrlich).
  { Erythrosin, alcoholic.

The sections should for preference be placed in a watch-glass, and covered with a stain of an aqueous nature. They may be safely handled with a camel-hair brush or section-lifter. To exclude dust, wine-glasses

with the stems removed are invaluable. As to the kind of watch-glass used, the author used the old-fashioned glass with flat bottom taken from obsolete watches. He procured quite a number, at the trifling cost of a half-penny each, from a dealer in old silver, who broke the watches up merely to get the silver from them. Some workers preferred to use small tubes for staining purposes, but he found that much time was wasted in extracting the sections from the tubes. To remove the excess of water stain, the glasses may be gently lowered into a photographic dish filled with water, and by the aid of a camel-hair brush the sections may be cleaned and still be kept in the glass. On removing the glass from the water, the excess may be drained off and the alcoholic stain added. The sections stain better if allowed to remain a long time in a weak stain, and the author found that for all practical purposes (especially for photomicrography) the sections are better stained after cutting than stained en bloc. The sections, after treatment with methylated spirit or absolute alcohol, may be transferred to the clearing medium, of which clove oil is the most commonly used. Xylol is good, but takes a considerable time to act. Creosote has also been recommended, but so far the author has not experimented with this. If clove oil is used, it must be well washed out with xylol, otherwise it seems to have a similar action on the balsam solution as glycerin has on a varnish, that is, it retards the drying process.

*Mounting the Sections.*—After clearing, the sections are ready to mount in balsam. The author usually bought this in the crude state, and dried it over a sand-bath, much to the disgust of other members of the household, who objected to the odour. When hard, this may be dissolved in xylol or benzole. He used the former, as most of his sections were cleared in this—at any rate, all ribbon sections. The cover-glasses and slips may be cleaned with potas. bichromate, or dilute nitric acid ; the author generally used the latter. To the beginner he recommends the thicker form of cover-glass at first, to get into the habit of cleaning the glass without breaking it. The author's first attempts in this direction were rather disastrous to his pocket, as he started, ignorantly, with $\frac{3}{4}$ in. circles of the thinnest variety, and spoilt the greater part of the first half-oz. in acquiring the knack of holding the circle without breaking it into many pieces. There are various forms of cover-glass cleaners to be had, but so far he had not made use of any. To ensure that the specimen remains in the centre of the cover-glass, it is advisable to put a small drop of balsam on the cover-glass, and, placing the specimen in this, to allow it to stand for some hours, excluded from dust. When sufficiently dry, take a clean slip, and place in the middle of the slide a drop of balsam. Now gently lower the cover-glass by the aid of a needle on to the slip, and, if placed in a slanting direction, the action of the descending cover-glass is such that all air-bubbles are excluded. The slide should now be placed in a slow oven, or allowed to stand for some days. Superfluous balsam may then be cleaned off with a rag moistened with xylol, and, after polishing, the slide may be placed on a turntable and ringed with a sable brush. For this purpose the author had a turntable mounted on a wooden roller-skate wheel. The varnish he generally used was either

asphalt or gold size. The latter may be obtained at the oilshop at ninepence the half-pint, or in smaller quantities at a similar rate.

*Paraffin Embedding.*—The specimens should be placed in fixing-fluid (chromo-acetic) for eight or ten hours. They are then removed to a tube containing water. This is changed several times during twenty-four hours. The next process is to decant part of the water, and add an equal part of alcohol to the water remaining. Allow to stand for six or eight hours, or more if tissues are strongly resistant. The 50 p.c. alcohol so formed is then replaced by 75 p.c. for five to six hours. This again is followed by 90 p.c. for a similar time. Finally absolute is added, and they may remain in this indefinitely. After the specimens have been fixed, washed, and finally dehydrated, they are placed in xylol for twenty-four hours. The next step is to place small pieces of the embedding wax into the tube. The xylol dissolves this and slowly infiltrates the specimen with wax and xylol. This is continued for twenty-four hours. The specimens are then removed to a beaker containing melted wax, and remain at a temperature of 55° C. in a hot-water oven. If the temperature is increased considerably, shrinkage will most certainly take place, so this must be guarded against with close attention to the recording thermometer of the oven. The author has constructed a small oven for this purpose by means of two square tins of different sizes, one soldered into the other. The outside tin contains the water, and the inside acts as the water-oven.

When thoroughly infiltrated, take a small Petri dish, and moisten with dilute glycerin and warm in the oven. Now pour into the dish the melted wax, and with a pair of heated forceps remove the specimens from the beaker of melted wax and place them in the Petri dish. Now gently place the dish on top of a filled basin of water, and still holding the dish by thumb and forefinger, gently blow with the mouth across the surface of the now setting wax film. When this setting film has well formed, rapidly sink the dish, and allow to remain for a few minutes in the water. Now remove the Petri dish and gently raise the hardened wax with a penknife. Taking the whole of the wax, carefully cut out the specimens so that a fairly symmetrical block of wax is obtained in each case, and finally trim to square prismatic form. The blocks are now ready to affix to the object-holder of the microtome.

The next step after fixing the block is to prepare the cleaned slips to receive the ribbon section. This is done by slightly smearing the slide with the finger-tip moistened with white of egg. This may be kept permanently by adding 50 c.cm. of white of egg to 50 c.cm. of glycerin and 1 gr. of salicylic acid. Next place the slips under water, and as the ribbons are cut place a suitable piece of each on a slide removed from the water. The ribbon now floats upon the remaining water on the slip. Gently warm the slip, and the ribbon will flatten out. Now drain off the water, arrange the section in the middle of the slip, and stand on its edge to finally drain for half an hour. The slips, when brought to this stage, are then allowed to dry in a temperature not above the melting-point of the wax for twenty-four hours; they are then ready for staining. This is usually done by hæmatoxylin, followed by a counter-stain. The method adopted in the author's own case was as follows:—

1. Pour xylol on warmed slip to dissolve the wax.

2. Pour absolute alcohol from corner of slip downwards, so that it drives off all xylol.

3. Place in dish of water for three minutes. For acid hæmatoxylin this must be distilled water.

4. For iron alum staining, remove the slides and place on each several drops of iron alum solution, and allow to stand for ten minutes.

5. Pour off iron solution and place in dish of clean water. Use plenty of clean water for each operation.

6. Remove slips and pour on drops of aqueous solution of hæmatoxylin. Stain for ten minutes.

7. Place slips again in clean water.

8. Now take each slip in turn, and with a glass rod apply drops of alcohol and HCl. The stain of specimens then turns red; the amount of de-staining required can only be learnt by experience, otherwise all the stain may be washed out. The slips are then again placed in a dish of clean water, when the stain again turns blue or black by the action of the tap-water.

9. Remove slips and pour on erythrosin (alcoholic) or any alcoholic counter-stain.

10. Wash off excess of stain with absolute alcohol.

11. Place in clearing-bottle of xylol. Old metal shaving-soap boxes make excellent clearing-tubes, as they are lined with paper, and do not corrode with action of xylol.

12. The slips may be removed after eight or ten hours, and finally mounted in xylol and balsam and dried in the usual manner.

For staining with acid hæmatoxylin, after the distilled water place some acid hæmatoxylin on each slip, and allow to stain for ten minutes; then wash off excess of stain in distilled water and transfer to dish of tap-water, where red stain turns blue. When this has occurred, remove slips, and counter-stain. Dehydrate, clear, and mount in balsam. In this method the stain attacks the film of albumin in the slip. To rid the slide of this, place in weak acid alcohol, and then finally wash with tap-water till the colour reappears.

Another method of fixing the ribbons to the slip may be of use. First place 1 p.c. solution of gum arabic on the slide; place the ribbon in and flatten. Drain off excess. Now irrigate from corner of ribbon with weak solution of bichromate of potash, expose to light for an hour, and finally dry off in an oven. For botanical specimens of a woody nature, it is said that this is a never-failing fixative.

With regard to mounting insect subjects, the author has made some attempts to mount specimens of the proboscis of the blowfly. This is done by first putting the fly under ether; then take the head and gently press it, when the proboscis will shoot out. Press a cover-glass over this on to a slip, and cut off at the base of the trunk. Irrigate with alcohol, which fixes the tissues; then clear in potash, wash out alkali, arrange parts, and place in alcohol again. Then transfer to turpentine to clear. Finally, mount in balsam.

With most insect parts the author used varying strengths of potash, according to subject in hand. Heat applied to the slide is often useful in this branch of work for removing air bubbles.

## Metallography, etc.

**Gold-copper Alloys.***—Gold and copper form a continuous series of solid solutions. Peculiarities in the hardness curve indicated, however, that the equilibrium diagram was more complex than had been thought to be the case, and N. Kurnakow, S. Zemczuzny and M. Zasedatelev have found that the $\alpha$ solid solution decomposes on cooling, two compounds CuAu and $Cu_3Au$ being formed. These compounds form solid solutions with an excess of their components, The microstructure of twenty-five alloys was studied. When quenched from about 800° C. the alloys consisted of a homogeneous solid solution. The structure of the alloys within certain ranges of composition was completely changed by annealing at suitable temperatures, owing to the formation of two phases. The temperatures at which the compounds are normally formed on cooling were established. The specimens were etched with aqua regia or by an electrolytic method.

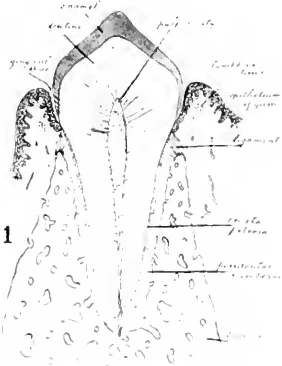
**Failure of a Copper Steam-pipe.**†—S. A. Houghton ascribes the bursting of a copper steam-pipe to the injurious effects of overheating during the process of brazing. Microscopic examination of specimens cut from the tube near the place of fracture revealed the presence of cracks and an excessively coarse structure, clear indications of " burning " of the copper.

**" Growth " of Internal-combustion Engine Cylinders.**‡—J. E. Hurst considers that the small changes in volume observed at the inner surface of cast-iron liners of internal-combustion engines are due to expansion among the grains ; the rapid succession of changes of pressure within the cylinder results in the entrance of gases and lubricant into the interstices of the grains by way of the graphite plates. The lubricant may be detected by microscopic examination, and is frequently troublesome during the polishing and etching of sections.

The formation of cracks in the piston-head of Diesel engines is apparently not due to growth. The piston-head is heated to a high temperature at its centre. Some of the graphite is probably dissolved by the iron and re-precipitated as temper carbon on cooling. This repeated action sets up alternate expansions and contractions, and the absorption of the graphite may leave small cavities. The temperature reached is probably near the melting-point of the phosphide eutectic. The radial cracks often found are probably due to a combination of causes of this kind with the rapid variations in pressure.

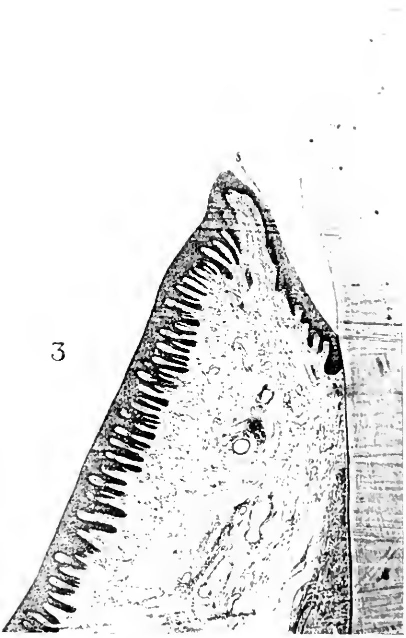
* Journ. Inst. Metals, xv. (1916, 1) pp. 305–32 (18 figs.).
† Engineer, cxxii. (1916) pp. 88–9 (1 fig.).
‡ Engineering, cii. (1916) pp. 97–98 (2 figs.)

1



2

3



4

JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY.

DECEMBER, 1916.

## TRANSACTIONS OF THE SOCIETY.

### XV.—*On Certain Parasites of the Mouth in Cases of Pyorrhœa.*

[*Preliminary Communication.*]

By Helen Pixell Goodrich, D.Sc., and M. Moseley.

(*Read October* 18, 1916).

Plates XII–XVII.

Pyorrhœa is such a widely distributed disease of the gums that it is hardly necessary to say much by way of introduction. To make sure, however, that the normal anatomical relations of the parts concerned are understood, it will be well to make brief reference to the microphotograph of a section taken transversely across the jaw of a puppy (figs. 2, 3).

For obvious reasons it is difficult to obtain human material suitably fixed for cytological purposes. Most of our series of

---

EXPLANATION OF PLATE XII.

Fig. 1.—Diagram of a section transversely across a Mammalian jaw from the labial to the lingual side, through a single root of a tooth.

„ 2.—Microphotograph of a section through the tooth of a puppy, in the same direction as above. × 7.

„ 3.—Microphotograph of the region round the gingival space of the section shown in fig. 2. × 35.

„ 4.—Microphotograph of a similar portion of a section through the tooth and gum of a person with fairly advanced pyorrhœa, showing the gingival space still free from organisms. A good deal of recession has taken place; the crusta petrosa may be seen to extend nearly to the top of the figure, showing where the gum was originally attached. Note that the lesion is at the top of the gum, where clumps of Leptothrix and pus-cells are scattered (the tartar ridge which was attached to the tooth just above here became detached during preparation of the section). The epithelium is much infiltrated with pus-cells. × 50.

sections are from dogs or cats; in these animals the disease runs much the same course as in man.

The normal tooth (figs. 1 and 2) has its roots deeply embedded in its socket in the bone of the jaw, and is separated from the bone by a layer of fibrous connective tissue, the peridontal membrane, and is firmly held in position by a strong ligament. This ligament is attached normally to the very top of the crusta petrosa at the place where this layer of bone joins the enamel of the crown. The epithelium of the gum dips down round the tooth and reaches the ligament. Normally the gum lies closely apposed to the tooth, practically obliterating the so-called gingival space (figs. 1–3).

Even in healthy gums leucocytes from the lymph glands may be seen making their way through the epithelium, and we maintain that these glands are the main source of the salivary corpuscles always found in the mouth, and not the tonsils as stated in text-books. The corpuscles which make their way through the epithelium opposed to the tooth collect in the gingival space ("espace péricervical"), where Mendel (*10*)* has recently recorded their presence in healthy persons. We have also found them in the very long gingival spaces round the incisors of rabbits with healthy gums.

We may now pass on to the pathological changes effected by pyorrhœa. Probably the very distressing symptoms are well known to you. The clinical aspects of the disease have been much discussed and the most diverse opinions and treatments put forward, often without much scientific basis. It is from the strictly scientific side that we wish to attack the problem, and the observations given here—the result of a year's study of many hundreds of cases—are merely by way of a preliminary communication.

The symptoms in advanced cases may be summed up as—

1. Acute inflammation of the gums, accompanied by the collection of pus and a large deposit of tartar round the teeth.

2. Absorption of the edge of the socket (alveolus) and recession of the gums so that a large portion of the tooth projects, and it later becomes loose and falls out.

From a study of mild cases it is quite clear that the lesion starts near the summit of the gum (fig. 4), not at the bottom of the gingival space, as the diagrams and description given by Bass and Johns (*1*, pp. 55, etc.) seem to imply. This space remains for a time remarkably free from organisms. The place where the inflammation starts is directly in contact with any tartar present (fig. 5). Unfortunately, during decalcification of teeth for histological purposes, the tartar ridge nearly always becomes detached; in the tooth shown in fig. 7, however, and on the lingual side of that shown in fig. 8, it remains more or less in position. The large

* The numbers within brackets refer to the Bibliography at end of the paper.

mass of tartar which was attached to the tooth shown in fig. 4 dropped away altogether; a section through the terminal branches of Leptothrix colonies from its surface is shown in fig. 14. All that is left in fig. 4 consists of loose clumps of Leptothrix and a good deal of pus in contact with the broken epithelium. The latter can be seen to be peeling off and to have already lost its characteristic regular appearance. At later stages (figs. 7 and 8) it disintegrates to such a great extent, and the remains become so much infiltrated with deeply staining pus-cells from the lymph glands, that it is almost unrecognizable. It is hardly necessary to point out how much the gum has receded in the figures; even in such a mild case as that represented in fig. 4 the crusta petrosa may be seen extending nearly to the top of the portion of dentine shown.

The peridontal layer may be seen in figs. 7 and 8 to have become very wide and necrotic-looking. It contains pus-cells and often numerous nests of nuclei which have been described as epithelial remnants. With regard to these we have not at present any conclusive evidence to offer. They are certainly sometimes present in apparently normal jaws, and, in some cases of pyorrhœa, especially in the cat, are very numerous; but we have hitherto found no micro-organisms in connexion with them, nor in fact in any part of the peridontal layer. The changes which have taken place in the bone of the jaw are apparent in both cases represented in figs. 7 and 8. The alveoli are much reduced, especially in the more advanced case (fig. 8), where the alveolus on the labial side has become quite flattened. On examining these sections with high powers numerous osteoclasts may be seen at work eating away the surface of the alveolus and also effecting lacunar absorption in all directions.

Some clinicians have objected to the name *Pyorrhœa* owing to the absence of a "flow of pus" in some cases in which recession is undoubtedly taking place. These are most interesting cases, and we are convinced that the absence of certain symptoms is only temporary and due to careful cleansing of the mouth by washes, etc. Recession in such cases is very gradual, but from continual observation of a few patients we are convinced that even here the recession is the result of inflammation. In fact our observations lead us to support the theory put forward by Znamensky (*16*) in 1902, that pyorrhœa always begins as an inflammation of the gums—so-called *marginal gingivitis*. Two cases of gradual recession that have come under our observation may be briefly mentioned, both in persons between thirty and forty years of age, whose mouths were thoroughly cleansed at least twice a day. In one of these the premolars and a molar on the left side showed very slight recession. From the molar the gum had receded a little more at the front than at the back, which there-

fore sloped downwards towards the front. The gum at the back of this tooth between it and the next molar was made to bleed by slight injury and then left. Next day there was a distinctly inflamed margin to the gum which appeared as a bright red rim round the back and sides of this molar. Special antiseptic precautions were then taken, i.e. mouth-washes used as often as possible. In about a week the inflammation entirely disappeared, but the gum was found to have receded a little more at the back, so that it was now nearly straight round the tooth.

In the other case the gums had receded from a canine and some other teeth sufficiently to expose the crusta petrosa, and after each short period of inflammation another narrow strip of crusta petrosa would be exposed, and this being living bone would cause great tenderness of the region for some days after the inflammation had disappeared. Thus even during a week or so of inflammation of the gum margin the alveolus appears to become slightly reduced. Possibly this may be owing to the increased number of lymphocytes in the neighbourhood, since these corpuscles are said to grow into osteoclasts and other macrophages.

Injury in such mild cases is perhaps often inflicted by the use

---

EXPLANATION OF PLATES XIII–XIV.

Fig. 5.—Extracted tooth, showing tartar ridge and gum flap which normally lies closely against the tooth, with the region at which it breaks in contact with the tartar. × 1.

,, 6.—Extracted tooth, showing by the tartar ridge that the gum had receded unequally, leaving pockets—an especially deep one down one root. × 1.

Figs. 7, 8.—Microphotographs of sections through jaws and teeth of cats with advanced pyorrhœa, showing tartar detached but nearly in its normal position. In fig. 7 a piece of vegetative tissue is jambed in on one side. The remains of the epithelium are infiltrated with the deeply staining pus-cells. The peridontal layer has become very wide. The alveoli are much reduced, especially on the labial side in fig. 8, and large lacunæ are developing in other parts of the bone of the jaw. × 11.

Figs. 9–14.—*Entamœba gingivalis.* Drawn with the aid of a camera lucida at an approximate magnification of 1500.

Fig. 9.—Living form with several lobose pseudopodia, and containing seven of the characteristic inclusions and a nucleus just discernible near the upper end.

,, 10.—Living form flattened out while feeding on bacteria, which may be seen passing inwards, enclosed in vacuoles, from the left upper side.

Figs. 11–14 from preparations stained with iron-hæmatoxylin.

Fig. 11.—Large amœba with no visible ectosarc, and the endosarc full of various food vacuoles.

,, 12.—Small form, with one large pseudopod composed of ectosarc.

,, 13.—An amœba, with two nuclei and two small lobose pseudopodia, and much food at various stages of digestion.

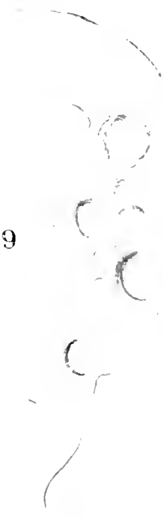
,, 14.—A portion of a section through a clump of tartar, showing amœbæ between the terminal branches of Leptothrix.

5

6

7

8



9

[Face p. 516.

of a hard toothbrush; this might account for the fact, pointed out to us by Mr. Buxton Ryle, of Oxford, that this kind of recession is liable to be more advanced on the left side of the mouth of a right-handed person, and vice versa. Of course there are many other ways of accidentally injuring the gums which will readily occur to all. Now, we should like to suggest that if after injury to the gum the teeth are not kept free from tartar and otherwise clean, the inflammation will increase and spread until a general gingivitis is caused, and that this, if not checked, will be followed by the appearance of all other symptoms of pyorrhœa.

This is, of course, merely a suggestion, and the only evidence in its support that we can give is the very common occurrence of general gingivitis and pyorrhœa among soldiers returning from active service. They nearly all say that it was practically impossible to keep their teeth clean while in the trenches, and the condition of their gums certainly improves rapidly after the removal of the tartar by a skilful dentist and the frequent use of antiseptic mouth-washes, etc.

There is one more point to be noted among general appearances, and that is the frequent occurrence of brownish, slightly refringent granules of irregular shape deposited just below the epithelium, apparently brought there by capillaries. By reflected light this substance appears black, and was first noticed on the flaps of gum left attached to extracted teeth, which are sometimes distinctly speckled with black in consequence.

It will be well before proceeding further to give a brief account of the positions in which the tartar or calculus is found. As will be explained below, this is of organic origin, the formative organism Leptothrix belonging to the higher bacteria or lower plants. When its growth is not interfered with it generally forms a ridge just at the margin of the gum. After calcification to form "hard" tartar this is very firmly attached, but in its earlier stages, when with other bodies from the mouth it forms the soft tartar (or "materia alba" of Leuwenhoek, 1683), it may easily be removed. In an extracted tooth (fig. 5) the ridge of hard tartar is just at the top of the gum-flap which generally comes away with it, since the gum breaks at its weakest spot, viz. the lesion opposite the tartar ridge. As the gum recedes the tartar follows it, and on very neglected teeth forms a continuous encrustation, but on those that are even occasionally cleaned the upper layers are removed to a greater or less extent, so that a ridge may generally be distinguished (fig. 6). The extent to which the ridge dips down on an extracted tooth shows the depth to which the pyorrhœa pocket had extended; for example, there is clear evidence of a deep pocket having existed down one root of the tooth in fig. 6. Sometimes a pocket will extend under the crown, and here also will be found a deposit of tartar. At other times a whole root may be found to be involved.

Leptothrix has also been in two cases found growing and forming nodules of tartar at the extreme apex of the root to which there were apparently no side pockets leading. In both cases, however, the crown of the tooth had been destroyed by caries, and no doubt the Leptothrix had entered through the root canal. It may be well to mention here that we can see no reason for separating tartar into two kinds. It would be impossible to say where, e.g., the line should be drawn between so-called serumal and salivary tartars in the cases just described.

We now pass on to describe some of the parasites and their characteristic positions. The mouth swarms with all sorts of organisms—Protozoa, spirochætes, yeasts, and especially bacteria in incredible numbers. A great deal of work has been done on these, especially the pyogenic bacteria, with a view to discovering the cause of the disease; but no particular bacterium has definitely been proved to be the cause, nor do the sections of the gum show any special invading organisms.

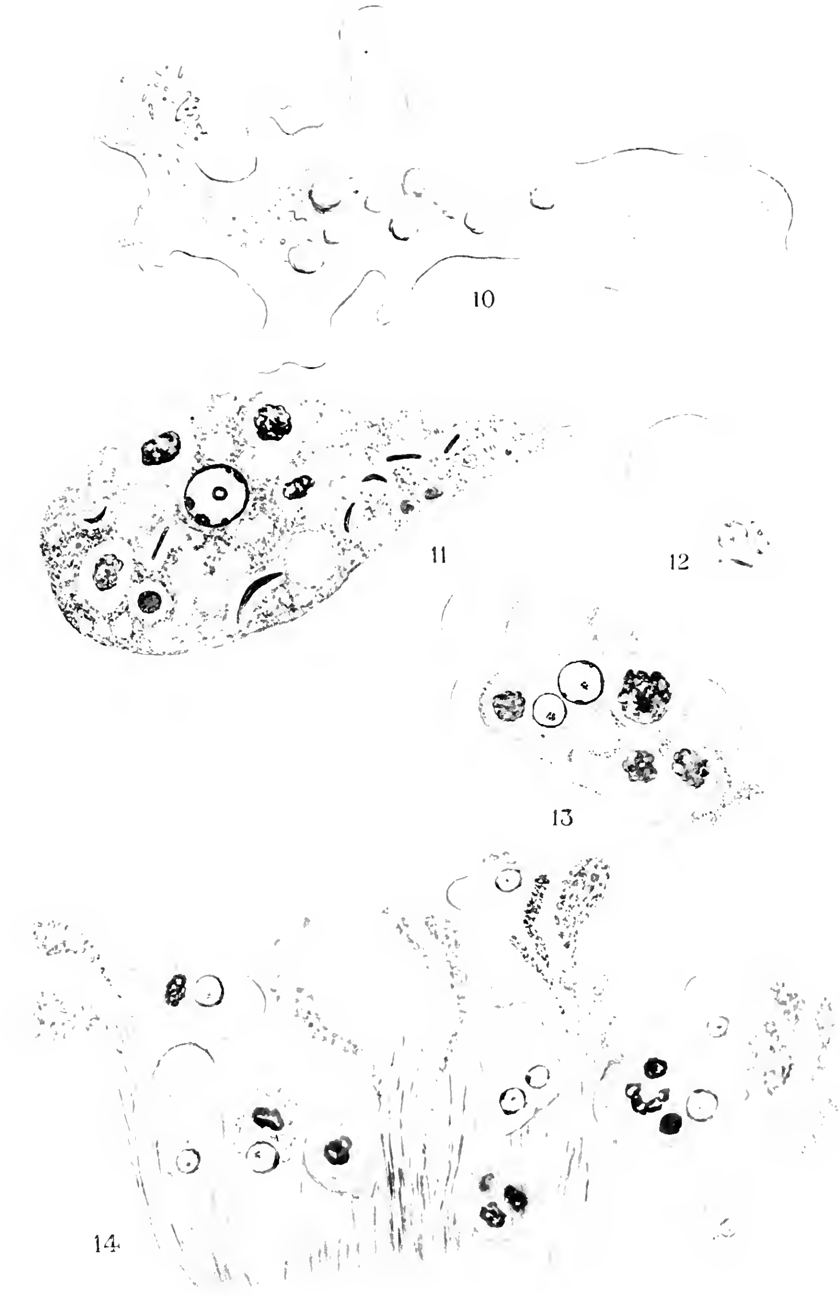
About two years ago a sensation was caused in the United States by the announcement by some Americans (*1*, *12*) that the amœba of the mouth was the specific cause; but, as we shall see, further research has not supported this view.

There is no reason to doubt that the mouth amœba is the one described and figured by Gros (*6*) in 1849 from the soft tartar of the teeth, and it should therefore be called *Entamœba* (or *Endamœba*) *gingivalis*, Gros, as has been well explained by Smith and Barrett (*12*). It is quite a common parasite of the mouth; even young children may harbour it. Probably infection passes from one person to another by direct contamination, as in kissing, using the same drinking utensils, etc. We maintain that it is not to be found in healthy mouths kept scrupulously clean by the use of suitable antiseptic mouth-washes, etc. Nor have we so far found it in healthy mouths of the few animals that we have tested, such as cats, rats, rabbits, sheep and a goat.

Its favourite habitat is the tartar, and here we come into opposition with previous observers of the amœba. It burrows, not into the tissues of the gum, as has been stated, but often between the terminal branches of the Leptothrix (fig. 14), and can generally be found in greatest numbers on the under side of the tartar ridge, where there is the greatest quantity of fresh pus. From what has been said about the position of the tartar, it will follow that sometimes the amœbæ are found in great numbers underneath the crown of the tooth, sometimes lower still, even at the apex of a root, if the pocket should extend so far. Two dogs with pyorrhœa that we have examined have shown numerous

---

For Explanation of Plate XIV, see p. 516.




H.P.G. del.

[Face p. 518.

amœbæ, but in ten or twelve cats with the disease in advanced stages we have only found them once. In both these animals the amœbæ, so far as we have been able to study them, are indistinguishable from the human one, *Entamœba gingivalis.*

## STRUCTURE OF ENTAMŒBA GINGIVALIS, GROS.

There is great variation in size among the ordinary vegetative forms. Sometimes chiefly small ones, measuring up to 10 or 15 $\mu$ in diameter, are found; at other times there will be numbers of large ones full of the characteristic inclusions and having diameters of 20–30 $\mu$. However, with a little trouble all intermediate sizes may generally be found. At the ordinary room temperature movement is somewhat sluggish, consisting in the extrusion of lobose pseudopodia in various directions without any actual change of place. On warming, the amœbæ become very active and sometimes move rapidly across the field of the Microscope, and may extend themselves to 100 $\mu$ or more in length. The pseudopodia consist almost entirely of the refringent, slightly greenish ectosarc (figs. 9, 10, 12 and 13). There is no contractile vacuole, but the endosarc contains usually many food vacuoles. In small specimens the contained food is often bacteria, but sometimes one or two of the large inclusions, so typical of the larger amœbæ, may be distinguished. There has been much discussion as to the nature of these inclusions, and they have been described as such mysterious things as "something of Protozoan nature"—Craig (*3*)—or "bodies only present in inflamed tissue." They are large, often 4–6 $\mu$ in diameter, refringent in the living, and stain readily with neutral red, Ehrlich's hæmatoxylin, and methyl-green. That is to say, they do not behave as the red blood corpuscles ingested by *Entamœba histolytica*, but seem to be composed of nuclear matter. In fact we consider that they are the nuclei of lymphocytes or other mononuclear leucocytes. In this connexion it is interesting to note that Mendel (*10*) has found 9 p.c. to 13 p.c. of the leucocytes in the gingival space to be mononuclears. On ingestion the small amount of cytoplasm would be rapidly digested, leaving the more indigestible nuclei in food vacuoles of the living amœba for a long time. Occasionally the branching nucleus of a polymorphonuclear leucocyte has been seen, also on one or two occasions a red blood corpuscle; but these are very rare. Though living amœbæ have been kept under observation for long periods (they will live in saliva or Ringer's solution in vitro for eight or nine hours) we have not succeeded in seeing any large body actually ingested. An amœba has been seen to flow round a mononuclear leucocyte for a long time without finally accomplishing its ingestion. When feeding on bacteria amœbæ have been observed on several occasions to flatten themselves out and extrude numerous fine branching

pseudopodia in all directions (fig. 10). These capture the small organisms, which may be seen passing towards the interior each in a tiny vacuole, and when the amœba reassumes its bulky form the endosarc appears to be a mass of small vacuoles.

The nucleus is seen with difficulty in the living (figs. 9 and 10), especially when much food is present. It shows up clearly, however, with such an intra-vitam stain as neutral red, and may then be seen to be of the vesicular form and to some extent compressible. There are generally a few granules of chromatin on its membrane. The small caryosome consists as a rule of a group of granules (figs. 12, 13); occasionally these form a ring (fig. 11), as is so often the case in *Entamœba histolytica*, which has a slightly larger nucleus. In *E. gingivalis* the nucleus is generally only 3 or 4 $\mu$ in diameter, but may be 5 $\mu$ or even 6 $\mu$ (fig. 11); possibly these latter are about to divide.

Reproduction, so far as we know, only takes places by binary fission, the nucleus dividing well in advance of the cytoplasm, so that two nuclei in a specimen have been seen on several occasions; these may be of different sizes, e.g. 3 and 4 $\mu$ respectively (fig. 13). Nuclear division is difficult to follow out in all its stages owing to the deeply staining inclusions. These appear to persist during the process, since two nuclei are found in amœbæ with vacuoles containing almost entirely digested food (fig. 13). If there be any sexual process or cyst production in the life-history of this amœba in the mouth it must be very rare. The only cysts that we have ever seen from the mouth have been obviously those of some free-living amœba of the Limax group (Vahlkampfia), i.e. small (8–12 $\mu$ in diameter), with a nucleus containing a large caryosome. The cysts described by Craig (*3*) from the mouth appear to be the same. Drs. Penfold and Drew, working in London, have recently cultivated an amœba from the mouth, but were disappointed to find that it had a contractile vacuole, and was obviously a free-living form and not *E. gingivalis*. That such cysts frequently find their way into the mouth from uncooked vegetables, etc., is proved by the fact that they so often reappear in the fæces.

All our attempts to grow *E. gingivalis* aerobically or anaerobically on various media and in association with different bacteria have been unsuccessful. (It may be of interest to point out that no parasitic amœba has ever yet been grown artificially.)

It is quite possible that there is more than one species of amœba in the mouth, but until some other stages in the life-history have been observed, inside or outside its host, it is premature to try to divide them.

It was in 1915 that Bass and Johns (*1*) produced an elaborate book in which they recorded the invariable presence of amœbæ in pyorrhœa lesions, and accused these Protozoa of being the specific

cause of the disease owing to the following erroneous assumptions:—

1. That they burrow down into the tissues destroying the peridontal layer and being found in greatest quantities in the deeper parts of the pockets. [It has already been mentioned that no signs of them can be found in the peridontal layer, and they only go below the gum when carried there by the sheltering tartar.]

2. That they are not found in healthy gums. [This statement has been contradicted by their own country-woman, A. Williams, and her collaborators (*14*), who record that they found amœbæ in 29 p.c. of New York children with healthy gums. Lewald (*9*) in 1907 had even recorded them in a much higher percentage of what he called healthy mouths.]

3. That emetin, which has such extraordinary amœbicidal action on *E. histolytica*, causes the amœbæ to disappear from the gums, and is followed by an improvement in their condition. [This they admit themselves in a subsequent note (*1*, p. 143) not to be invariably true, and in none of the few cases that we have kept under observation during injection of emetin ($\frac{1}{2}$–1 gr. a day for six days) have the amœbæ disappeared for any length of time. In fact not at all generally, and in one their disappearance for a few days we ascribe to the unaccustomed oral cleanliness, kept up under our supervision, as much as to the effect of the drug.]

Another argument against *E. gingivalis* being a potent cause of pyorrhœa is the fact that in advanced cases there are sometimes very few—many less than in other milder ones. In fine, the short notoriety, that the amœba had for about a year as the cause of pyorrhœa, has practically already died down.

Another Protozoan parasite sometimes present in pyorrhœa lesions is *Trichomonas*. This is presumably the same species, *T. hominis*, found in the human intestine, where, if in large numbers, it appears to give rise to a mild form of dysentery. In the mouth it is generally only present in small numbers, and we have not so far studied it specially. It lives, as would be expected, for a much longer time outside the mouth than the amœbæ. There is no evidence at all in support of its having any particular connexion with pyorrhœa.

## Description of the Leptothrix of the Mouth.

The white deposit to be found attached to and between the teeth is chiefly composed of colonies of Leptothrix, which we believe to be a pleomorphic organism. In examining the colonies great care should be taken to obtain them from the mouth in as unbroken a condition as possible. They have a high degree of tenacity, but if the material, scraped, say, from the tartar ridge, be teazed out with needles or made into a smear as in making

ordinary bacteriological preparations, the broken parts of colonies will present a hopeless confusion. It is simply due to these methods of preparation that the fact has not hitherto been recognized that by far the greater proportion of the white deposit consists of colonies of this highly organized bacterium or parasitic alga. The easiest way to obtain unbroken colonies, or well-preserved portions of large colonies, is from extracted teeth. Part of the tartar ridge not disturbed by the forceps should be chosen, and some of the Leptothrix from the surface gently scraped off with a needle, and transferred to a drop of Locke's solution, or one of half Locke and half Gram's iodine, on a slide. If too thick a lump, it may be divided with a needle into smaller portions, and a cover-slip then gently pressed down to flatten out the preparation sufficiently to examine it. It must be remembered that the colonies have often been broken and disturbed whilst still in the mouth, unless they are in a sheltered position such as in a pyorrhœa pocket, from which beautiful little free colonies may sometimes be obtained. Balls of Leptothrix colonies pressed out from the tonsil-crypts also provide excellent unbroken material. To make permanent preparations of Leptothrix, portions of colonies should be carefully selected in Locke's solution or saliva under a dissecting microscope; they should then be arranged in a drop on one cover-slip and another pressed gently on top, and the whole immersed completely in some fixing solution, preferably freshly-made Carnoy or Schaudinn, and left there for about ten minutes, after which the cover-slips should be gently separated. One or other of them will probably show fairly good clumps fixed in a flattened condition. We have found Stephens' ink the best stain for colonies fixed in this way; and, for small separated branches, Giemsa or iron-hæmatoxylin (long method).

Leptothrix colonies vary immensely, but a fairly typical specimen of a small unattached well-developed colony (fig. 15) shows the following structure. The centre of the colony is a nodule of hard tartar, from which radiate bundles of long coarse threads divided into segments of variable length, which usually give a reddish-purple reaction with Gram's iodine (fig. 18). The groundwork between these bundles is filled in with granular or coccoid forms and traversed by numerous finer threads, most of which do not give the iodine reaction. We have never observed any true

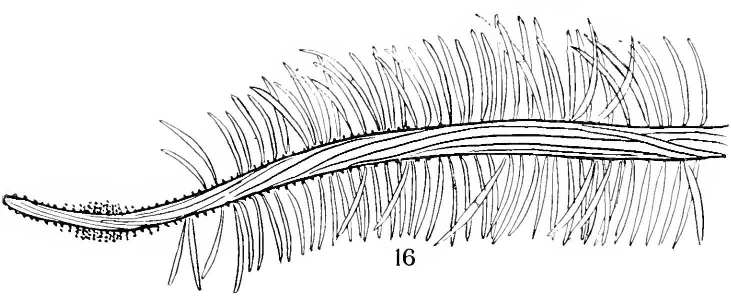
EXPLANATION OF PLATE XV.

The magnifications stated for the following figures, Nos. 15–21, are approximate. Figs. 15, 16, 17, 18, 20 and 21 represent optical sections. Figs. 17 and 20 show Leptothrix colonies flattened under cover-slips.

Fig. 15.—Diagram of a portion of Leptothrix colony, stained with iodine, which shows up the coarse bundles of threads. × 425.

,, 16.—Diagram of a "bottle-brush" branch. × 2000.

15



16

M. M. del.

branching of the Leptothrix threads. The radiating bundles of relatively coarse threads divide and subdivide before reaching the periphery of the colony and may finally end in a few threads. These may project far beyond the general surface of the colony, and, being usually covered with coccoid forms, and finer and shorter threads set more or less at right angles to this axis, form a terminal branch, one of the many of very variable form with which the whole surface of the colony is thickly beset. The coccoid forms on the branches appear to be set in rows radiating from the axial threads. This arrangement is well seen in specimens of branches stained with Stephens' ink. In the solid mass or groundwork of the colony, however, their arrangement cannot be made out. Threads of Leptothrix often show terminal swellings or "clubs," both inside the colony and at the periphery. These are very prone to calcify (fig. 19).

Where a colony is growing on the surface of a tooth or other attachment it is of course modified in shape, but the bundles of coarse iodine-reacting threads always radiate from the centre of attachment, and there the hard tartar is deposited, chiefly by the progressive calcification of these threads, and is thus built up layer by layer as the colony grows and spreads. The forms of Leptothrix colonies vary considerably according to their position in the mouth. Those most branching and diverse are met with usually where the tartar ridge meets the surface of the gum-flap. Colonies situated above the surface of the gum margin, slightly higher up on the tooth, have usually less complicated branches. A variety frequently found on colonies in this position has been described as "flowering heads" by various writers (fig. 20). They are well illustrated in two microphotographs by Leon Williams (*15*), reproduced by Goadby (*5*). The young colonies found scattered over the surface of the tongue (fig. 17), and radiating from a core of a few dead epithelial cells, are often entirely composed of coccoid forms, these coccoid forms being set in regular rows, with alternating areas of finer or coarser granules, all apparently radiating from their centre of growth. The Leptothrix also flourishes on the surface of decaying dentine, its threads radiating from the decayed surface, and as a rule very little or no tartar is deposited when it is growing in this position. The Leptothrix also grows on foreign bodies in the mouth; thus we have found it growing abundantly on a fish-vertebra which had become lodged between two teeth in a cat. It has also been described by Leber and Rottenstein (*8*) growing on substituted human teeth, with decalcification taking place in exactly the same way as in ordinary caries. Under certain conditions as yet unascertained * the Leptothrix colonies develop

* We have not found this kind of branch on perfectly healthy extracted teeth or in healthy mouths. We always find it on extracted teeth from advanced cases of pyorrhœa. It usually abounds in pyorrhœa pockets.

branches of a peculiar type, as shown in our illustrations (figs 16, 21). To these we have given the name of "bottle-brushes." They consist of a few central threads with innumerable fusiform bodies, which are usually slightly curved, so set upon this stem as to make it resemble a little fir-branch. Sometimes these fusiform bodies appear to be firmly attached to the branch, but in other specimens they may be watched coming off the axial threads in clouds, and in this condition they appear to be motile. They have often already divided into a diplobacillary form, while still attached to the stem. Branches are frequently found which have already shed these bodies from their distal portions, but are still closely beset with them lower down. In this condition the distal portion of the branch is seen to be covered with little coccoid bodies which at a later stage appear to have budded off more coccus forms in the typical radiating rows, while the lower portion may still be covered with fusiform bodies. This fusiform bacillus appears to be the one associated with a spirochæt in Vincent's angina.* With regard to the "iodine reaction" recommended by so many authors for differentiating the different species of bacteria found in the mouth, we have made the following observations:—The radiating bundles of coarse threads usually give this purple-red reaction; the intensity, however, varies very much, from nearly black to a hardly discernible tint. If long coarse threads project singly far beyond the surface of the colony they almost invariably do not give the reaction. Some of the finer threads in lobose branches of a colony usually give it, but as a rule it is only a few at intervals that do so. Sometimes a whole colony fails to give the reaction. Occasionally whole branches stain deeply with iodine—central threads, shorter radiating threads, coccus-form, and all. In a cat we have even found bottle-brushes with the attached fusiform bacilli staining right through. Often a few areas of the coccus-form in a colony give the reaction. It seems to us that the iodine reaction may be regarded as merely showing the presence of a food substance which may be stored in different parts of a colony.

* On a few occasions it more resembles the *Bacillus necrosis* (see Ellermann (*4*)), that is to say, it is longer, and has a striated appearance due to the distribution of the granular contents.

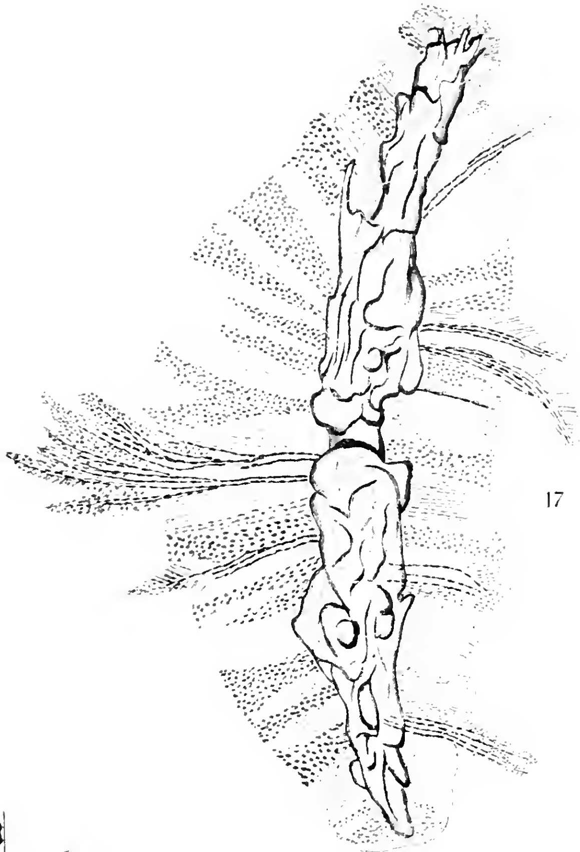
---

## EXPLANATION OF PLATE XVI.

Fig. 17.—Young colony of Leptothrix from the tongue, growing on a core of dead epithelial cells, which are already partly calcified. Drawn from a fresh preparation stained with iodine. The coarse threads leading to little branches gave the iodine reaction. × 300.

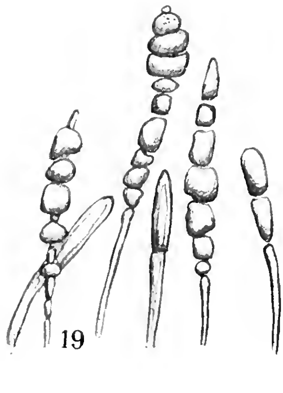
" 18.—Two coarse threads of Leptothrix, stained with iodine, showing the granules giving the purple reaction in the segments. × 3500.

" 19.—A group of partly calcified clubs, from the periphery of a Leptothrix colony. × 625.



17

18



19

M. M. del.

[Face p. 524.

The cause of the deposit of hard tartar was described by W. D. Miller (*11*) as a chemical reaction. The $CO_2$ in the saliva was said to escape on reaching the mouth, and, the alkalinity of the saliva thereby becoming greater, the salts, being then less soluble, were deposited. As proof of this, test-tube experiments were adduced, and the fact that more tartar is deposited on those teeth near the openings of the salivary ducts into the mouth was supposed to settle the matter. Exactly the same explanation is given in "The Science and Practice of Dental Surgery," by Bennett, in 1914. In this work it is admitted, however, that the deposit of hard tartar in some positions, notably on the roots of teeth which had apparently no lesion leading to the mouth-cavity, presented difficulties. We have already described the positions in which hard tartar is found, but we have never found any unless the Leptothrix was there depositing it. The abnormal amount of tartar formed in pyorrhœa is a marked feature of the disease, both in man, cat, dog, and also, we hear from Dr. Broom, in the acute pyorrhœa of the golden moles of South Africa, *Chrysochloris hottentota* and *asiatica*, where not only the whole of the milk-dentition is rapidly lost from this disease, but the germs of the permanent teeth are so injured that they fail to errupt. In the tonsil-crypts we have found the Leptothrix growing in large colonies, some of them depositing hard tartar in their centres. It is probable that tonsil-stones are due to this cause. It will possibly be found on further investigation that some calcareous stones from other parts of the body have the same origin. Those occurring in the salivary ducts are particularly likely to be of this nature.

It is worthy of note that the sore surface in pyorrhœa is always found opposite the tartar ridge, and consequently in juxtaposition to the colonies of Leptothrix with which the ridge is covered. The Leptothrix follows down the recession and abounds in the pockets formed. According to R. von Jaksch (*7*) it grows abundantly in the lungs, in fœtid bronchitis and gangrenous lung affections. Von Jaksch says that by Leptothrix he means the *Bacillus maximus buccalis* of Miller. If we have correctly identified the fusiform body, it appears to have some relation to Vincent's angina and hospital gangrene. We merely indicate these positions in which the Leptothrix is found in order that it may, we hope, not be entirely overlooked in future as a possible cause of other diseases as well as of pyorrhœa.

The Leptothrix was described by many early investigators with varying degrees of accuracy. The first to study it with detailed attention was Vicentini (*13*). His descriptions of what he called *Leptothrix racemosa* (including under this name both species of Leptothrix described by Miller as well as other organisms) were not altogether correct, and its pleomorphism unfortunately led him to the remarkable conclusion that all forms

of human pathogenic bacteria were derived from this one parent plant. It is to his preposterous claims for the organism that we must attribute the neglect of later investigators to follow up his observations. Leon Williams (*15*), one of his contemporaries, dealt with a few points in Vicentini's work, and described a method of staining the colonies with methyl-violet. W. D. Miller, writing about the same time, would not allow the existence of the organism at all as such, but divided it up into several kinds of bacteria. His classification and nomenclature have been partially adopted by later writers on the subject. We only propose here to refer to one of his kinds—namely, *Bacillus maximus buccalis*—in the hope of clearing up some of the confusion which has arisen over the use of the name. Miller applied the term to the coarse iodine-reacting bundles of threads which we have just described in the Leptothrix colonies. His description and illustrations leave no doubt upon this point. He says it most frequently occurs as parallel-running or crossing bundles of segmented filaments which give the iodine reaction. Goadby (*5*), while accepting Miller's classification of the so-called "ungrowable" mouth bacteria, describes under *B. maximus* (in which he includes *B. maximus buccalis* and *Leptothrix buccalis maxima* of Miller) an organism which he has grown on various media. His description, however, in no wise tallies with Miller's. Goadby's organism is motile and forms endogenous spores; a few of its threads give the granulose reaction on certain media; he says nothing about its running in parallel bundles. Bennett (*2*) describes *B. maximus buccalis* as a large bacillus with segments 5–6 $\mu$ long (Miller gave them as 2–10 $\mu$) forming definite chains, which sporulate, but only when grown outside the mouth! He says it is non-motile, and that he means the organism described by Miller as *B. maximus buccalis*. He also says nothing about its iodine reaction nor about its running in parallel bundles. We wish to suggest that the *B. maximus buccalis* of Miller has not yet been grown artificially, and that it cannot be so grown until the whole Leptothrix colonies, of which it forms an integral part, have been cultivated on artificial media.

There seems to be no doubt that the fusiform bacillus has been grown in pure culture, and also that it sometimes grows out into threads. By supplying the cultures with various substances

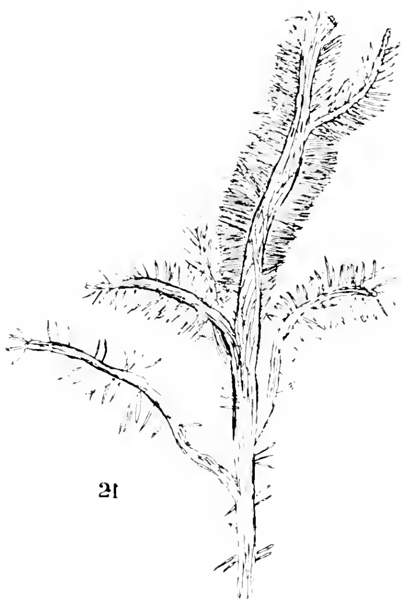
---

EXPLANATION OF PLATE XVII.

Fig. 20.—Part of a colony of Leptothrix, with "flowering head" branches. Drawn from a fresh preparation. The axis of this kind of branch consists of a single swollen thread. Some branches are seen in optical section. × 625.

„ 21.—A "bottle-brush" branch. Drawn from a preparation stained with Stephens' ink. × 600.

20



21

M. M. del.

[Face p. 526.

possibly necessary for its growth, we intend to attempt the cultivation of complete colonies of Leptothrix; this we recognize to be the only conclusive proof that the fusiform, coccoid, and filamentous forms are all parts of the same organism.

We may sum up by stating that pyorrhœa lesions differ from other suppurating sores in that no organisms appear to invade the tissues. Possibly they are kept out by the normal flow of leucocytes being so greatly increased as soon as the epithelium is injured. In any case we cannot yet definitely accuse any organism of being the primary cause of the gingivitis with which we feel sure the disease begins, but are inclined to incriminate the Leptothrix.

In conclusion, we should like to express our great indebtedness to the authorities of the Radcliffe Infirmary, Oxford, especially Major Gibson, D.M., for the use of a laboratory in that institution; also to the dental surgeons who hold clinics at the Infirmary and have provided us with much material. Mr. Kendrew and Mr. Pettey have especially given us assistance. Mr. E. S. Goodrich has given us much valuable advice and help during the progress of the work; and we are also much indebted to Sir William Osler, not only for suggesting the study of this disease, but for the great help he has given us throughout the course of the research.

## Bibliography.

1. Bass, C. C., & F. M. Johns.—Alveolodental Pyorrhœa, Saunders, 1915.
2. Bennett, N. G.—The Science and Practice of Dental Surgery, 1914.
3. Craig, C. F.—Observations upon the Endamœbæ of the Mouth. Journ. Infect. Diseases, xviii. (1916) pp. 220–38.
4. Ellermann, V.—Einige Fälle von bakterielle Nekrose beim Menschen. Centr. f. Bakt., 1 Abt., Orig., xxxviii. (1905) p. 383.
5. Goadby, K. W.—Mycology of the Mouth, 1903.
6. Gros, Fragments d'Helminthologie et de Physiolgie microscopique. Bull. Soc. Imp. de Nat. de Moscow, xxii. (2) (1849) pp. 549–73.
7. Jaksch, R. von—Clinical Diagnosis, English translation, 1905.
8. Leber & Rottenstein.—Dental Caries, English translation, 1878.
9. Lewald, L. T.—The Presence of Amœbæ in the Mouths of Healthy Individuals. Proc. New York Path. Soc., 1907.
10. Mendel, J.—L'exsudat gingival et le stade précurseur de la Pyorrhée alvéolaire. Comptes Rendus Soc. Biol. lxxix. (1916) pp. 587–93.
11. Miller, W. D.—Mikroorganismen der Mundhöhle, 1889.
12. Smith, A. J., & M. T. Barrett.—The Parasite of Oral Endamœbiasis, *Endamœba gingivalis* Gros. Journ. Parasit. i., June 1915.
13. Vicentini. F.—Bacteria of the Sputa, English translation, 1897.
14. Williams, Anna.—Significance and Prevention of Amœbic Infections in the Mouths of Children. Journ. Amer. Med. A., Dec. 11, 1915.
15. Williams, J. Leon.—Dental Cosmos, 1899.
16. Znamensky, M. N.—Alveolar Pyorrhœa; its Pathological Anatomy and its Radical Treatment. Journ. Brit. Dent. Assoc. xxiii. No. 10 (1902) p. 585.

# XVI.—*Studies in Pleomorphism in Typhus and other Diseases.*

By Edward C. Hort, M.D.

(*Read November* 15, 1916.)

When a few days ago I accepted the courteous invitation of your Honorary Secretary to place some of my work before the Society I did so with mingled pleasure and pain. The pleasure lay in the opportunity of placing before this learned and ancient Society certain observations on the morphology of so-called simple bacteria, and the pain consisted in the fact that with the exception of what I have to show you in typhus fever my work is not yet sufficiently far advanced to justify any claim to finality. I was in fact not ready for publication when your invitation arrived, but Mr. Martin Duncan most generously came to my aid, and by dint of incessant work has prepared the beautiful photographs which he will show you.

The three subjects I wish very briefly to touch upon, and which the photographs will illustrate, are pleomorphism, the true botanical position of certain of the so-called lower bacteria, and the relationship of filterable viruses to non-filterable organisms.

## Pleomorphism.

This word, signifying as it does merely multiplicity of form, is often restricted to reputed mutation phenomena, supposed examples of which are repeatedly cropping up in morphological studies. On the whole the sum of experience appears to be against morphological mutation, though one or two distinguished biologists to-day are wise enough not to deny the possibility of its occurrence. With this variety of pleomorphism I am however not concerned to-day. What I wish particularly to bring to your notice is a very different kind of pleomorphism which can easily be studied in both unicellular and multicellular organisms. It is no doubt true that one would perhaps hardly use the term pleomorphism to describe the different developmental morphological phases in passing from the impregnated ovum to the full-blown frog. But this is merely because we are here watching the development of the individual over considerable periods of time. On the other hand, in the case of unicellular organisms with a complex life-

history where perpetuation of the race takes place so rapidly that we can see many of the phases represented on a film at any given moment, it is perfectly accurate to speak of pleomorphism, so long as one makes it clear that one is not referring to genuine mutation phenomena—if such there be. The Protozoa and the parasitic fungi supply excellent illustrations of my point.

## The True Botanical Position of Bacteria.

This use of the word pleomorphism leads naturally to my second heading, the true botanical position of the so-called simple bacteria, and I will summarize what I have to say on this subject in the form of this question: Are we justified in assuming, as many of us do, that some of the lower forms of bacteria—to use a text-book phrase—are really what they seem? Are we certain that there exists any form of living thing, however lowly, condemned for countless ages, past and future, to reproduce itself exclusively by the simple process of (transverse) division into two equal parts?

Our experience of comparative biology is wholly opposed to the reasonableness of such a view, even when held by bacteriologists of repute who believe that a coccus or a bacillus can only reproduce itself as a coccus or a bacillus, and who pin their faith on the unconvincing observation that it will remain true to type under standard cultural conditions in the laboratory. Now, in my belief, it is just because the confectionery of the laboratory—to borrow from Sir William Collins' well-stocked armoury—is more or less standardized, as compared with the unstable, ever-shifting culture media presented by infected tissues, that we have gone astray in this matter. And it is precisely this which originally led me, as doubtless it has led others, to careful morphological and cultural study of certain micro-organisms in their natural milieu—the infected tissues themselves, blood, cerebrospinal fluid, and so forth. The story is too long a one to tell here, but this at least I may say, with confidence, that if you wish to determine the true botanical position of a pathogenic "bacterium" you will in the first place often find it necessary to use the body fluids themselves as the optimum culture media before attempting its study in synthetic products. And even then you will have often to use unaccustomed methods of cultivation in order to avoid error.

I must not, however, go here into details of technique, and will only remind you that recent research has shown us that many of the so-called bacteria have now been definitely proved not to be bacteria at all, in the limited sense above defined. Familiar examples are to be found in the streptotricha and sporo-

tricha, many members of these for long being regarded as true bacteria, whereas we now know them to be parasitic fungi of the hyphomycetic type.

Now, the true botanical position of these organisms, such, for example, as the bacillus of Koch, was primarily arrived at by prolonged morphological study, a branch of bacteriological observation which in these days is in some danger of being neglected, owing to the counter-attractions presented by study of "antibodies" in test-tubes. And this neglect of "bacterial" morphology has, I think, had this unfortunate result, that it has led many a worker to assume that perfectly genuine examples of pleomorphic activity are merely examples of contamination, either by extraneous organisms or by secondary invaders. By this I mean that cultures are frequently rejected because they appear to be contaminated, when in reality they are often pure cultures, not, as supposed, of bacteria, but of parasitic fungi in the botanical sense. In any case of doubt it is, of course, always necessary, when visible organisms are being studied, to cultivate from single individuals; but even then it is often useless to be content with cultivation on standardized laboratory media only. But even in the case of growth from single colonies it is most dangerous to assume contamination from the mere fact of pleomorphism, for the simple reason that it may prove that we are here dealing, not, as supposed, with bacteria, but with a fungus, or other organism, with a complex life-history which may demand, and often does demand, special methods of attention to make it reveal its true nature. If, in fact, a good technique has been observed, the very occurrence of pleomorphism, especially if repeatedly confirmed, is strong presumptive evidence that we have before us not a bacterium but a fungus, or other unicellular organism with a complex life-history. And, as you will see in the case of typhus fever, the additional work involved by realizing this possibility becomes amply justified.

In the study of infective disease in man, this question of contamination is again and again being brought up, and in the study of those of the exanthemata to which I have specially addressed myself—namely, to cerebrospinal fever, typhus fever, scarlet fever, measles, typhoid fever, and paratyphoid fever—this question of careful scrutiny of alleged contamination is absolutely fundamental. In all these diseases, as well as in many others, one organism peculiar to each disease repeatedly appears: the meningococcus of Weichselbaum in cerebrospinal fever; the *Diplobacillus exanthematicus* in typhus fever; a streptococcus of sorts in scarlet fever; the bacillus of Eberth in typhoid fever; the *Bacillus paratyphosus A* in one form of paratyphoid fever, and so on. In each of these diseases the particular organism appears with remarkable constancy, and, speaking generally, in no others. In each case the particular organism is believed by its discoverer to be the cause of

the particular disease. In each case the discoverer is, in my view, both right and wrong. He is wrong in so far as he believes the organism to be a simple bacterium responsible as such for the production of the disease. And he is right in believing that his organism is intimately associated with the disease, though he has not yet learnt that his bacterium represents only a phase in the complex life-history of a parasitic fungus, or perhaps of a protozoon, and as such cannot itself reproduce the disease. I refer here only to typhus fever, as it is only in this disease that my evidence is as yet approximately complete. And this brings me to my third heading.

## The Relationship of Filterable Viruses to Non-Filterable Bacteria.

Your President, when introducing me to this Society, referred in graceful terms to my work on infective disease, and suggested that my views are known not to be orthodox. He is right. I am not orthodox, and am in fact frankly a heretic as regards the etiology of the exanthemata. I do not believe in, and cannot accept, the current teaching as to the causal agents of the diseases I have studied—namely. cerebrospinal fever, typhus fever, scarlet fever, measles, typhoid fever, and paratyphoid fever—and my heresy is based on this simple fact, that it has so far proved impossible to show that any of these diseases can be produced in animals by injection of pure cultures of the "bacteria" generally implicated.

Now, in the case of typhus fever, I was able to show two years ago that it is possible to cultivate from the filtered body fluids the *Diplobacillus exanthematicus* of Rabinowitsch, an organism which, when fully developed, will not pass the fine bacterial filters employed. These experiments I have now repeated on a very large scale, and am satisfied as to the accuracy of the observations. Full details will be published elsewhere. It is sufficient here to say that these human filtrates are highly infective, and that their injection into monkeys reproduces in these animals a disease indistinguishable from that produced by injection of the unfiltered body fluids, and that from monkeys injected with the latter I am now able to recover at will further infective filtrates, and from these filtrates I am again able to recover the "bacillus" in question. And I further find that in suitable media, such as acidified broth, it is possible to force this "bacillus" to reveal its true nature as representing merely a phase in the life-history of what appears to be a parasitic fungus allied to the hyphomycetes. As the photographs will show, unmistakable evidence suggesting a fungoid nature reveals itself in the sporulating "bacilli," isolated spores and mycelial-looking growth.

Here, then, we have an excellent example of an organism posing as a bacterium, ready perpetuation of its bacilloid and coccoid phases on laboratory media being entirely responsible for our misinterpretation of its true nature. But the point to which I wish particularly to invite your attention is the fact—of general biological interest—that this organism in typhus fever exhibits during its life-history a phase so minute as to be capable of passage through the fine bacterial filters employed, and that this later develops into the full-grown organism which is non-filterable. Moreover, I have the best possible reasons for believing that I shall shortly be able conclusively to demonstrate the same principle at work in cerebrospinal fever, in scarlet fever, in measles, and in the enteric group, and that we are here touching a fundamental law operative also in many other of the infective diseases.

I wish, however, to make it clear once more that in the photographs Mr. Duncan will show you I am at present claiming nothing conclusive in the case of the typhoid and paratyphoid preparations, which are only shown to-night because they illustrate points in the typhus micro-organism which I am now satisfied is not a bacterium at all, in the sense frequently applied to that term. The films you will see under the microscopes are mostly stained by Gram's method, whilst the photographs are from acid congo-red preparations. This adsorption method, though devised many years ago for botanical work, was independently thought out by my friend and colleague, Dr. Benians, for bacterial work. I have found it, as you will see, of the greatest value in testing the truth of my thesis as to the true botanical position of many of the so-called bacteria, and I feel certain that in the future Dr. Benians' method will largely replace the indian ink method in morphological study.

Dr. Hort then rapidly outlined the special difficulties to be encountered in the study of films prepared from killed organisms, with special reference to genuine and spurious branching, and to the post-fission movements of "snapping" and "slipping" described by Hill in 1904. He then summarized the evidence afforded by the photographs of genuine sprouting, drawing particular attention to what appeared to be sagittal segmentation as the earliest sign of sprouting, and pointed out that "snapping" forms of post-fission movements apparently occurred in the case of all the three types of organism selected for demonstration. And he concluded from this that if Hill was right when he laid it down that "snapping" was peculiar to the Corynebacteria, then the *Bacillus typhosus*, the *B. paratyphosus A* and the bacillus of typhus fever were, strictly speaking, not true bacteria, especially

if the occurrence of this phenomenon, and of genuine sprouting, were confirmed by a series of photographs of living individual organisms.

He also pointed out that to attempt to explain aberrant types of bacterial morphology by calling them involution forms was merely a confession of ignorance. Personally, he had in the case of young freely growing cultures, such as these were, no idea of what was meant by an involution form, though the term might perhaps be legitimately employed to describe the bizarre deformities seen in dying or dead individuals in old and unsuitable media.

## XVII.—*New Tank, and Pond-weed Holder, to be used with the Greenough Microscope.*

By Sydney C. Akehurst, F.R.M.S.

(*Read November* 15, 1916.)

Plates XVIII–XIX.

The tank is all metal, with an aperture at the bottom $1\frac{7}{8}$ in. by $\frac{7}{8}$ in. Over this is cemented a cover-glass, which works clear of the stage, the base being counter-sunk to allow this. The height of the front is $1\frac{1}{2}$ in., the back 2 in. This variation admits of it being used on the Microscope when inclined. The width is $1\frac{1}{2}$ in., and the base 3 in. by $1\frac{5}{8}$ in. The sides slightly taper to accommodate the shape of the paired objectives, and allow working to the edge of the field. The fluid capacity is 3 oz.

Water to be examined is poured into the tank, and, as most free-swimming organisms are phototropic, they soon gather in the field of view, and an opportunity is given of watching them in all aspects, as there is ample room for movement. Owing to the wide mouth of the tank, a comparatively large surface of the water is in contact with air, and it is possible to retain pond-weed in the water for the purpose of aeration without obstructing any part of the field. Organisms can, therefore, be kept in a vigorous condition for prolonged observation.

The contents of the receptacle can either be removed or added to, and there is ample working space to take out any object of interest with a pipette whilst the objectives are in focus. Any free-swimming forms slow to react to light can be confined within a limited area in a well at the bottom of the tank, over which a cover-glass is placed.

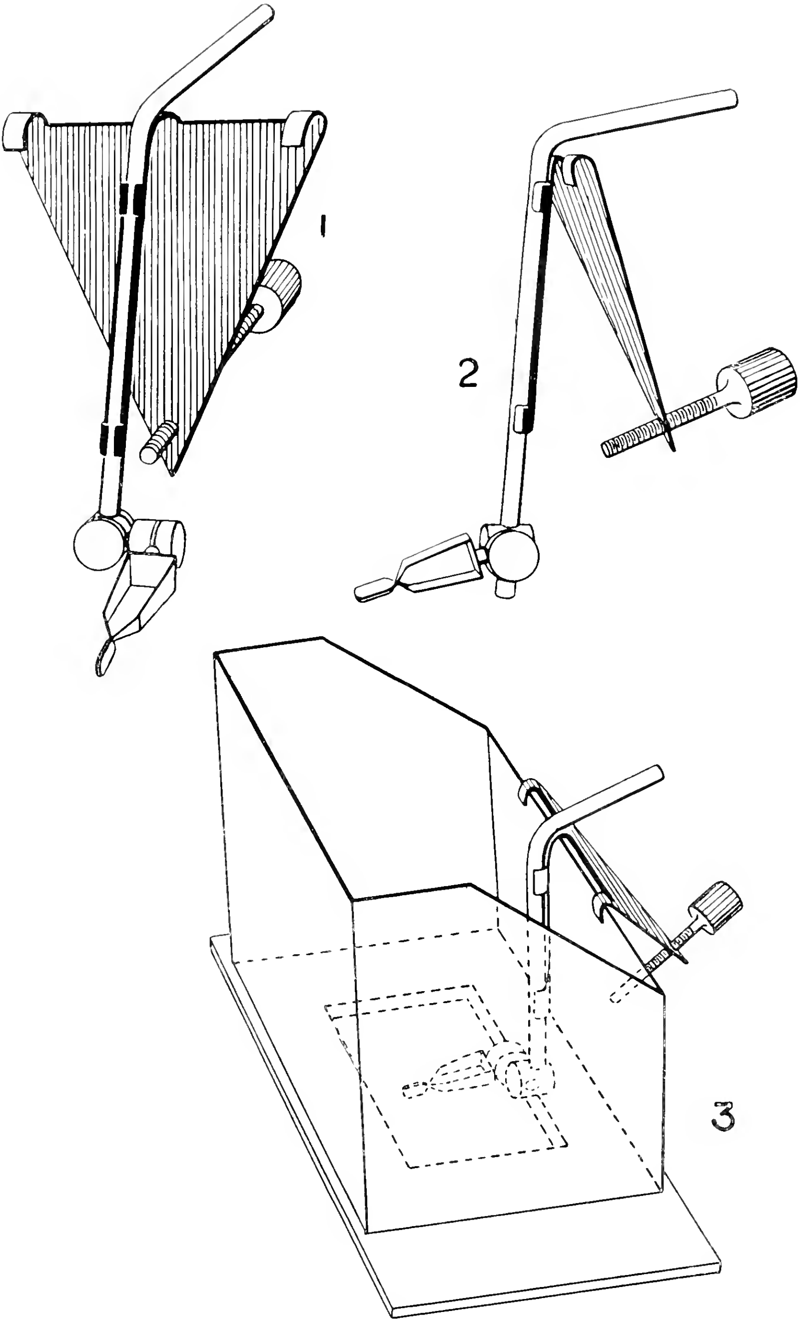
The weed-holder hangs by two hooks from the front of the tank. It has universal movement, which admits of any fixed form on pond-weed being viewed in various positions. When necessary to change the weed, the holder can be lifted from the tank without disturbing any other part of the apparatus.

Easy access to fixed or free-swimming organisms whilst under

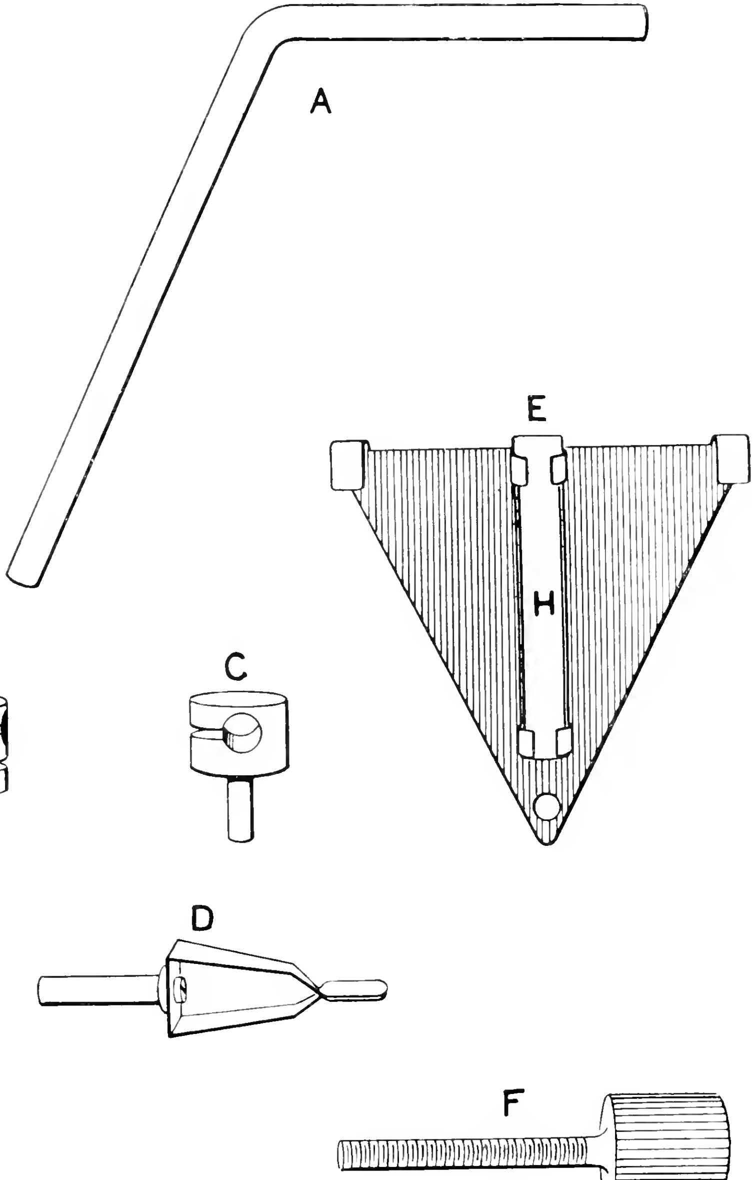
---

EXPLANATION OF PLATE XVIII.

1.—Weed-holder, front view, consisting of six separate pieces.
2.— Ditto, side view.
3.—View of Tank, with holder in position.




[Face p. 534.


A
E
H
B
C
D
F

observation is very essential, and a tank with a large open mouth provides for this, but it can only be used in conjunction with low-power, immersed objectives. The immersion objective used on the Greenough Microscope is a Leitz 24 mm. According to the maker's list this has an initial magnification of 8·14 diam., and eye-pieces have been provided giving up to 170 diam. The condenser employed is one by Swift, which has a long working distance, and is specially useful for pond-life.

To give an idea of the kind of image that can be obtained, using dark-ground illumination, I have been able to display the cilia of a small alga, *Denobryon cylindricum*, at a magnification of 132 diam., and the definition was quite good. To see *Volvox* in stereoscopic relief, with cilia actively working, is an impressive sight, and the same might be said with regard to the crisp and bright image given of fixed forms, such as *Melicerta* and *Floscularia*.

When working with low-power immersion objectives in an uninterrupted medium for which they have been corrected, one is employing ideal conditions for the proper presentment of an object, and the results obtained with pond-life encourage the hope that something will be done to produce, say, two powers—$\frac{2}{3}$-in. and $\frac{1}{2}$-in. immersion objectives*—to be employed with the monocular. The Zeiss Plankton Searcher, which is the only low-power water-immersion objective I am familiar with, gives an excellent image, but is not a convenient lens to handle; the working distance, 36 mm., is too long, and it yields a low magnification only.

I have already worked out a tank and weed-holder for the monocular, and the dimensions will be different from those of the tank for the Greenough, owing to the somewhat limited working space on the former instrument. It can, however, be put to the same use as the binocular tank, with an additional advantage of holding in a fixed position small free-swimming forms between two glass covers—in the same manner as employed with the Rousselet live-box.

* With working distance of 25 mm. and 13 mm. respectively.

---

EXPLANATION OF PLATE XIX.

A.—Shaft which slips into the holder H on the triangular metal plate E.

B.—Solid metal drum, with two holes bored through; into one hole fits the shaft, the other takes the peg on drum C.

C.—Solid metal drum, with one hole bored through; this takes the peg of the duck-bill clip D.

D.—Duck-bill clip and peg; the clip revolves and can be placed in a position either perpendicular or horizontal to the bottom of the tank.

E.—Triangular metal plate, on which is the shaft holder H and two hooks; the hole at the apex takes the metal screw F. This part of the weed-holder is in one piece.

F.—Screw which controls position of the duck-bill clip, moving it either towards or away from the back of the tank when the holder is in position for use.

# OBITUARY.

## Edward Francis Hodges. 1851–1916.

It is with great regret we record the death of Dr. Hodges, which took place at his summer home in Vermont, on July 11. He was born at Boston, Mass., on August 1, 1851, and his early life was spent principally at Lincoln, Mass., a small town some sixteen miles from Boston. In 1867 he entered Harvard, and graduated in Arts and Letters in 1871. He studied medicine at Georgetown University, where, in 1874, he won his first M.D. After a year spent in Europe and travelling in Egypt and Syria he returned to Boston and entered Harvard Medical School, where he graduated M.D. in 1877. During his Harvard career he came under the influence of such men as Asa Gray, Oliver Wendell Holmes, Louis Agassiz, Charles W. Eliot, President of Harvard, and Emerson and Lowell.

In 1880 Dr. Hodges settled in Indianapolis, where he taught various branches of medicine in the Colleges for more than thirty years. He taught Physiology in the Indiana Dental College, and was the first Professor of Pathology in the Indiana Medical School, in 1884, where he was the Professor of Obstetrics for over twenty-five years. He was elected a Fellow of this Society in 1885.

In addition to his achievements in medicine and surgery, Dr. Hodges was an expert rifle-shot; a connoisseur in the collection and classification of gems; an authority on Indian lore and relics; a sailor, to the extent that he could tie the requisite sixty-five knots with ease; an accomplished classical scholar; a traveller of broad experience and understanding, and a student of literature. Dr. Hodges was a man of great personal charm. His keen love and appreciation of the beauties of nature had been with him all his life, and probably dated from his boyhood acquaintance with Thoreau.

A. W. Sheppard.

# CORRECTION.

Page 441, 3rd line from foot—*for* egg-shell *read* egg-cell.

# SUMMARY OF CURRENT RESEARCHES

RELATING TO

# ZOOLOGY AND BOTANY

(PRINCIPALLY INVERTEBRATA AND CRYPTOGAMIA),

# MICROSCOPY, ETC.*

## ZOOLOGY.

### VERTEBRATA.

#### a. Embryology.†

**Continuity of Elements in Early Stages of Blastoderm.**‡—J. Cameron and R. J. Gladstone have studied this in early stages of frog, chick, mouse, and other forms. They have come to the following conclusions:—1. In the developing blastoderm the nuclei, with their contained chromatic material, ought to be regarded as the structural units rather than the cell-elements as a whole. 2. There is an organic continuity between the cell-elements of the developing blastoderm both in Vertebrates and Invertebrates. (The authors have traced this continuity up to the three-layered stage in Mammals and in the chick embryo, in the chorionic villi and in the placenta.) 3. This continuity is in most cases primary, and not secondary (plasmodial rather than syncytial). 4. Protoplasm may be differentiated into endoplasm and ectoplasm. The nascent endoplasm forms a clear, highly refractive zone immediately surrounding the nucleus. This merges into a more mature endoplasm, which in its turn undergoes transition into a granular ectoplasm. 5. The nascent endoplasm, the more mature endoplasm, and the ectoplasm represent three stages in the genesis of protoplasm. It is a well-recognized fact that the protoplasm of every living tissue has a limited period of activity during which its vitality is constantly being revived and rejuvenated by regulated supplies of nascent material. The latter is apparently a derivative of the nucleus, and is discharged

* The Society are not intended to be denoted by the editorial "we," and they do not hold themselves responsible for the views of the authors of the papers noted, nor for any claim to novelty or otherwise made by them. The object of this part of the Journal is to present a summary of the papers *as actually published*, and to describe and illustrate Instruments, Apparatus, etc., which are either new or have not been previously described in this country.

† This section includes not only papers relating to Embryology properly so called, but also those dealing with Evolution, Development, Reproduction, and allied subjects.

‡ Journ. Anat. Physiol., l. (1916) pp. 207–27 (15 figs.).

from this in the form of nascent endoplasm. It would appear, therefore, that nutritive material ingested by the cytoplasm receives its final elaboration in the nucleus. The nascent endoplasm has probably the greatest activity, while the functions of the ectoplasm are more passive and mainly in the direction of maintaining structural continuity between neighbouring cell-elements. 6. The ectoplasm corresponds to the so-called intercellular substance, and forms an essential part of the continuous living tissue which with its contained nuclei constitutes a plasmodium.

**Tissues of the Ovary in Marsupialia.***—C. H. O'Donoghue has investigated the corpora lutea and the interstitial tissue in the ovary in Marsupials. For this study he used chiefly three forms: *Phascolarctos cinereus*, *Trichosurus vulpecula*, and *Didelphys aurita*, but other species were used for purposes of comparison. He finds that the membrana granulosa in the three species studied is composed of typical polygonal cells arranged three or four cells deep round the ripe follicle. The theca folliculi is composed of internal and external layers, does not contain any included interstitial cells, and its cells are always readily distinguishable from membrana granulosa cells. The corpus luteum in *P. cinereus* is formed by the irruption of both layers of the theca folliculi, which burst through the membrana granulosa and form a lining on its inner side. This method of formation is similar to that in *P. obesula*, *P. nasuta*, and *M. ruficollis*. The ripe follicle collapses in *T. vulpecula* when the ovum is extruded, and the central cavity is at once obliterated. The theca folliculi is drawn in with the membrana granulosa, which it penetrates, and the connective tissue becomes irregularly distributed through the body. It is unlike the process in any other Marsupial so far examined, but to a certain extent resembles that in the mouse. In *D. aurita* the thecal irruptions do not at once go through the membrana granulosa, but push it before them until the central cavity is practically filled in, and then they break through and form the central plug of connective tissue. In one example, a very early stage, mitoses were found in the cells of the membrana granulosa, and this was the case also in *P. obesula* and *P. nasuta*. The corpus luteum in *P. cinereus* remains hollow even when fully grown, and the central cavity does not get filled in till after the birth of the young, apparently not until the gland has started to decline. This condition is apparently unique. In *T. vulpecula* the corpus luteum is fairly typical when full-grown, save that its connective tissue is much more irregularly arranged than in other Marsupials. The condition of the corpus in *D. aurita* is very similar to that in *D. viverrinus*. In no case is the membrana granulosa shed, nor does the theca interna contribute to the lutein cells of the corpus luteum.

The interstitial tissue. There is present in the ovary of certain species of Marsupials a tissue which corresponds histologically to the interstitial tissue in the ovary of the higher Mammals. The cells are always distinguishable from ordinary stroma cells, cells of the theca interna,

* Quart. Journ. Micr. Sci., lxi. (1916) pp. 433–73 (1 pl.).

old lutein cells, or the cells of an atresic follicle, and there is no evidence that any of the three last are at any time transformed into interstitial cells. Such cells are present in the pouch young of *T. vulpecula* before they could have been derived from any of these sources. Interstitial tissue is to be regarded as a tissue *sui generis*, although it is possible that it may originate from stroma cells at a very early stage. The tissue is irregularly distributed in the various species of Marsupials, and it is worthy of note that it is present in all the Diprotodontia and absent in the Polyprotodontia so far examined. It may be present only as a few small groups of cells, or in such quantity as to form by far the largest part of the bulk of the ovary, excluding corpora lutea, e.g. in *P. penicillata*. The tissue has a typical glandular appearance, but, as no satisfactory account of its function has yet been put forward, it seems preferable to retain the term interstitial tissue or cells rather than to call it a gland.

**Theory of Sex.***—E. A. Goeldi discusses the nature and origin, determination and significance of sex in the light of modern investigations. Two general conclusions are emphasized. The first is that differentiation of the sexes has to do with the conservation and rejuvenescence of species. The second is that optimum conditions favour the production of females rather than males, and that hard conditions of existence favour the production and predominance of males. The paper has graphic illustrations.

**Inhibition of Development of Artificial Parasitism.**†—G. A. Belogolowy has made the experiment of putting eggs of frogs into the body-cavity or into the tissues of frogs (*Pelobates*). He implanted fifty eggs of *Pelobates*, and after autopsies four months afterwards he found eighteen of them again. An account is given of their appearance—usually densely black spheres, from 0·5 to 4 mm. in diameter, flattened on the side next the organ to which they were attached. They were multicellular and showed peculiar tissues, for the most part embryonic.

In the free stages the spheres were somewhat uniform masses of pigmented tissue, with a connective tissue envelope, which sometimes grew inwards. In fixed stages capillary vessels appeared. Capsules inside the spheres contained peculiar free elements, which the author calls X-cells. Later on there was a multiplication of these, and a mass of embryonic tissue resulted. But besides this there was often a "mimicry" of adjacent host-tissue.

The "mimicry" is not due to adjacent host-tissue growing in. The resemblance is usually to connective tissue, rarely to hepatic tissue. Some of the spheres form colonies in the body-cavity. On the whole, the spheres remain at a blastula level. There is no exception to the occurrence of the X-cells. A description is given of primitive pigmented tissue, several kinds of connective tissue and other approximations to some development on the part of the spheres. The differences in the

* MT. Nat. Ges. Bern, 1916, pp. 140-203 (12 figs.).

† Nouv. Mem. Soc. Imp. Nat. Moscow, xviii. (1914) p. 1-50 (3 pls.).

spheres according to their parasitic relations are discussed. Plasmodia may arise among the X-cells, and amœboid cells may pass into the body of the host. The spheres illustrate no mere inhibition of development, but a peculiar divergence of development. The author discusses the theoretical bearing of his results, especially on the recapitulation doctrine. It is maintained that the actualization of potential characters in development requires a more or less precise environment of nurture; if that is radically changed the organism may develop otherwise.

**Effect of Pituitary Substance and Corpus Luteum Substance on Egg-production and Growth.***—Raymond Pearl continues his investigation of this, and finds that feeding laying hens with the desiccated substance of the anterior lobe of the pituitary body of cattle, at a time of year when the rate of fecundity is declining, does not stimulate the ovary to an increased rate of production. Growing pullets similarly fed do not show any earlier activation of the ovary. Growing chicks similarly fed show retardation in growth in body-weight, as holds in Mammals also. Feeding with the desiccated substance of corpus luteum brings about a retardation of growth about twice as great in amount as that following pituitary feeding. Neither substance given to laying pullets causes any retardation in the attainment of sexual maturity as indicated by the laying of eggs. The birds so fed begin to lay eggs at the same age as the controls, but with a smaller body weight.

**Winter Egg-production in Fowls.**†—Raymond Pearl discusses his experiments towards improving by selection the winter production of eggs. The character is Mendelian in its genetic behaviour, depending upon two factors, one of which is sex-linked. Mass selection for egg-production (during the first ten years) was not effective, but selection (during the last seven years) which was based upon the performance of the progeny was extremely and quickly effective. The phænotypic variation of the character fecundity, in fowls, markedly transcends, in extent and degree, genotypic variation. It is quite impossible in the great majority of cases to determine with precision what is a hen's genetic constitution with respect to fecundity from an examination of her egg record alone. In this case, as in so many others, but in an unusually pronounced degree, a sure diagnosis of genetic constitution can only be made by means of the progeny test. If high-layers are selected by the egg record alone, the breeder is not really selecting genetically high-producers, except in a portion of the cases, and he makes no progress in building up a highly fecund strain. To be effective in changing the average productiveness of a flock of poultry, selection must pick out those birds as breeders which carry the factors for high fecundity genetically, i.e. as an integral part of their hereditary make-up, and not any other birds.

There is no evidence that the genotypes themselves were changed by the selection. What the selection did was to change the constitution of the population in respect of fecundity genotypes. Those individuals

* Journ. Biol. Chemistry, xxiv. (1916) pp. 123–35.
† Amer. Naturalist, xlix. (1915) pp. 595–608.

were sorted out whose progeny were high-producers, and the others were rejected. The author adheres to his view that the absolute somatic value of a particular hereditary factor or determinant (i.e. its power to cause a quantitatively definite degree of somatic development of a character) cannot be changed by selection on a somatic basis, however long continued.

**Three-legged Kitten.***—W. B. Kirkham and H. W. Haggard describe the structure of a three-legged kitten, the left fore-limb being apparently absent. The scapula showed no coracoid process; the glenoid cavity was very imperfect and convex rather than concave; the left humerus was minute and without marrow cavity. It is probable that after starting to grow out normally from the body the limb-bud encountered some obstacle which pressed it against the body and checked its increase in length. Such of it as had already grown underwent further development into bone, muscle, and connective tissue on a reduced scale.

### *b.* Histology.

**Colloids and Tissue Structure.**†—Raphael Isaacs has experimented in reference to the relation between the properties of colloids and fresh tissue structure, as observed under the Microscope by dissection or compression methods or in hanging drops. The clear-cut pictures of the fixed and stained tissue are absent, as well as the fibrillar structures characteristic of fixed sections. The tissue colloid changes rapidly on removal from the body, swelling or coagulating.

The experiments made show that when tissues are removed from the body for examination in the living condition, any change in refraction indicates a dehydration, a gelation, or a solution process, which, beyond narrow limits, tends towards irreversible changes in the state of the cell colloids. Both dehydration and gelation increase the refraction. An optical change in the tissue colloids is noticeable only after considerable change in concentration, but is more readily noticeable if the change is from the sol to the gel state or the reverse.

The pattern produced on coagulation or fixation is due to a shrinking and to diffusion currents, which cause the granules which are precipitated to whirl around, finally becoming wound up in the parts which coagulate more slowly. The pattern for a dilute and a concentrated colloid is the same, the former yielding a more delicate fixation figure than the latter. The physiological state of a tissue at the time of fixation can thus be worked out. The action of physiological salt solutions in preventing swelling due to acid intoxication is not uniform for all the constituents of the cell. Slight variations in the strength of the salt solution may give false impressions as to the relative densities of the cell constituents, because of the different rates of dehydration.

* Anat. Record, x. (1916) pp. 537–42 (3 figs.).
† Anat. Record, x. (1916) pp. 517–22.

**Poison-organ of Sting-ray.***—H. Muir Evans has made sections of the poison-organ of *Trygon pastinacea*, first described by Porta in 1905 as lying in two grooves on the ventral surface of the sting. The gland arises from a special layer of epithelium starting at the root of the spine; the secreting tissue consists of regular follicles with ducts and central and lateral canals; the secretion is discharged by means of nipples or filaments projecting from the canals; there is a layer of muscular tissue surrounding the central canal; the staining reactions of the secretions are like those of the poison of the weever; there is no doubt as to the genuineness of the toxicity.

**Growth-rings on Herring-scales.**†—G. W. Paget and R. E. Savage contribute a note summarizing such additional evidence as they have obtained from a fresh series of investigations with regard to the structure and significance of the rings on herring-scales. Their studies included a comparison of dorsal and lateral scales from the same fish; a comparison of the effect produced when the scale is examined under polarized light with that obtained under ordinary conditions; and an examination of the ring in section. The investigations yield important corroborative evidence of the truth of the view that the transparent rings mark recurring periods of minimum growth.

### c. General.

**Fauna of Jordan System.**‡—Nelson Annandale finds that this fauna is mainly Palæarctic, but with a distinct Ethiopian element, which may be due to the existence in Pliocene times of a river flowing southwards into the Indian Ocean from what is now the Jordan system. The Ethiopian system consists exclusively, or almost exclusively, of fishes with great vitality and adaptiveness. The absence or paucity of Ethiopian forms among the Invertebrates of the system may be due to an obstruction of the outlet of the Lake of Tiberias and a fatal increase of salinity. The Palæarctic element is composite and of comparatively recent origin, consisting mostly of species from the north and east, but also of a few of Nilotic origin. The northern and eastern Palæarctic animals, in cases in which they had no powers of independent progression on land, probably reached the system through floods or other occasional agencies. The Nilotic species are mostly amphibious and may have arrived on their own feet or wings.

**Cranial Muscles of Mammals.**§—F. H. Edgeworth gives an account of the pharyngeal, laryngeal, and hypobranchial muscles of *Ornithorhynchus* and *Echidna*. He also discusses the development of these muscles in *Dasyurus viverrinus* and some other Marsupials, in the pig

* Proc. Zool. Soc., 1916, pp. 431–40 (7 figs.).
† Proc. Roy. Soc., lxxxix. (1916) pp. 258–60.
‡ Journ. and Proc. Asiatic Soc. Bengal, xi. (1915) pp. 437–76.
§ Quart. Journ. Micr. Sci., lxi. (1916) pp. 383–432 (13 pls.).

and the rabbit. The similarities and differences between the cranial muscles of Monotremes, Marsupials, and Eutheria are dealt with. In many particulars of the cranial musculature adult Monotremes are more primitive than Marsupials and Eutheria, but some of the cranial muscles in Monotremes exhibit special transformations. Marsupials are more primitive than Eutheria in regard to certain respects of the cranial musculature. Certain developmental changes which, on comparison with Monotremes, appear to be of importance in the phylogenetic history of the cranial muscles of Marsupials and Eutheria occur in the pouch stage of *Dasyurus*, but are omitted or slurred over in the development of the pig and rabbit.

**Skull of Chrysochloris.***—R. Broom has studied sections of the head of a young specimen of *Chrysochloris hottentota* and a prepared skull of a slightly older skull of *C. asiatica*. He finds that the skull of this interesting type is in part primitive, and in part specialized and degenerate. It is primitive in the structure of Jacobson's cartilage, in the feeble development of the inferior turbinal, in the simple columella-like alisphenoid, in having a large maxillary zygomatic process, in the possession of a large complicated pterygoid which articulates with a large basisphenoidal process, and in the possession of a distinct tabular bone. It is degenerate and specialized in the rudimentary condition of the orbitosphenoid, in the loss of the ectopterygoid interparietal, and jugal, and the lack of development of a zygomatic process of the squamosal. The examination of the skull confirms the result of the examination of Jacobson's organ and its relations in showing that *Chrysochloris* is not a near ally of *Centetes*, and that it is not an Insectivore. It is not allied to the Menotyphla and requires a distinct order, Chrysochloridea.

**Classification of Reptilia.**†—E. S. Goodrich maintains that the group Reptilia represents not a true monophyletic class like the class Mammalia and the class Aves, but rather an assemblage or grade of Amniotes retaining a more primitive general structure. The Reptilia thus include a basal *Protosaurian* group of amphibian-like forms leading to a central point from which diverge two main branches—the *Sauropsidan* branch leading to the birds and the *Theropsidan* branch leading to the Mammals. The modern classification based chiefly on the skull is very uncertain. The development of a hook-shaped fifth metatarsal and of a mesotarsal articulation, and the subdivision of the aortic trunk so as to form two systemic arches crossing at their base in such a way as to become separated by the interventricular septum, clearly distinguish the Sauropsidan from the Theropsidan line of evolution.

**Conspicuous Patterns.**‡—J. C. Mottram has sought to define experimentally the conditions of conspicuousness, trying plain and

* Proc. Zool. Soc. London, 1916, pp. 449–59 (1 pl.).
† Proc. Roy. Soc., Series B, lxxxix. (1916) pp. 261–76 (4 figs.).
‡ Proc. Zool. Soc., 1916, pp. 383–419 (20 figs.).

patterned objects against plain backgrounds and against patterned backgrounds. He illustrates the occurrence of conspicuous patterns in nature by reference to Indian Lepidoptera. He submits a graphic classification of coloration according to utility :—

<table>
<tr><td rowspan="7">Colour and Pattern</td><td>Unrelated to the Visual Perception of other Animals</td><td colspan="3">For the absorption of Light Rays<br>For the absorption of Heat Rays<br>Excretory Products, etc.</td></tr>
<tr><td rowspan="6">Related to the Visual Perception of other Animals</td><td rowspan="3">Inconspicuous to other Animals</td><td>To the eyes of enemies</td><td>Protective coloration</td></tr>
<tr><td>To the eyes of prey</td><td>Aggressive coloration</td></tr>
<tr><td>To the eyes of friends</td><td>?</td></tr>
<tr><td rowspan="3">Conspicuous to other Animals</td><td>To the eyes of enemies</td><td>Attracting and repelling and warning coloration</td></tr>
<tr><td>To the eyes of prey</td><td>To allure prey, as in Mantidæ</td></tr>
<tr><td>To the eyes of friends</td><td>Social signals<br>Sexual signals</td></tr>
</table>

**Cranial Nerves of Anolis carolinensis.***—W. A. Willard has made a detailed study of the cranial nerves of this North American lizard. All the typical nerves are present except the spinal accessory. The ganglia of V, VII, IX, and X are distinct, and the roots issue by independent foramina. The ophthalmic ganglion shows no fusion with the other portion of the Gasserian ganglion. There is a wide distribution of sympathetic ganglion cells along the afferent rami of the cranial nerves, sometimes forming definite ganglia. There seems to be a typical Sauropsidan type of sympathetic system in the head. The course of the somatic sensory, somatic motor, viscero-sensory, and viscero-motor components is described. There is a relative reduction of the somatic sensory nerves. The morphological character of the fibre of different components is sufficiently differentiated to form types peculiar to each component. The distinction in character appeared to be less than that described for the lower groups of Vertebrates, but there was considerable individual variation in the size of fibres.

The skin is well supplied with special tactile organs, which are more abundant along the jaws than elsewhere. These organs are quite generally, if not always, covered by a thinned plate of the horny layer

* Bull. Mus. Comp. Zool. Harvard, lix. (1915) pp. 17–116 (7 pls.).

of the epidermis, which bears in its centre a tapering "hair." The distribution of taste-buds is such as to preclude their innervation (save a very limited number in the laryngeal region) by anything except the chorda tympani and palatine VII. A large proportion of the fibres carried by these rami are for such sense-organs, their innervation fields being covered for general sensory purposes by the somatic sensory of V.

**Eels and Eel-culture in Valencia.***—A. Gandolfi Horyold gives an interesting copiously illustrated account of eel-culture and eel-fisheries in the Albufera region, and discusses the whole natural history of the eel, including structure, habits and life-history.

**Reproductive Migration of Tunny.**†—Louis Roule has studied the movements of *Orcynnus thynnus*, and finds evidence of a regular seasonal migration to a spawning area. Those that are caught in spring by the Italian and Tunisian fishermen have previously lived in or near French waters, and those that people the Mediterranean off the French coast have their birth-place off the Italian islands and Tunis. There is no evidence of migration from the Atlantic into the Mediterranean. The tunny prefers to keep to waters of the same temperature and salinity.

## Tunicata.

**Indian Museum Tunicata.**‡—Asajiro Oka deals with seventeen species of simple Ascidians, ten of which are new. These include *Monobotryllus violaceus* g. et sp. n., especially interesting in its close resemblance to certain compound Ascidians, such as the Botryllidæ and the Polystyelidæ. The reproductive organs consist of a number of hermaphrodite polycarps arranged in two rows, one on each side of the endostyle. In the structure and arrangement of the polycarps it comes near Michælsen's *Monandrocarpa*. It connects Styelidæ and Polystyelidæ.

The collection is also interesting on account of its containing five well-preserved specimens of an extremely aberrant simple Ascidian, very probably belonging to the genus *Hexacrobylus*, of which only one specimen has hitherto been known. The branchial sac is much reduced, narrow, with intact walls without stigmata. The branchial siphon has a quite unique shape—a very short but wide tube bent in a curve, with one end compressed so as to represent a bilabiate mouth, and the wall on the convex side puffed out in the form of a hemispherical dome. Another rarity is a species of *Megalocercus*—a large Appendicularian with voluminous spiracular passages which occupy nearly the middle third of the trunk.

* Algunes observaciones sobre la anguila en Valencia. An. Inst. Gen. y Técnico de Valencia, 1916, pp. 1–44 (17 pls.).

† Comptes Rendus, clxv. (1916) pp. 35–8.

‡ Memoirs Indian Museum, vi. (1915) pp. 1–33 (5 pls.).

**Budding and Statoblasts in Tunicates.***—Marc de Selys-Longchamps describes in *Stolonica socialis*, one of the Polystyelidæ, a peculiar mode of budding. On stolons, which are diverticula of the body-wall, buds are isolated which become statoblasts. Their further development does not give rise to a colony properly so called, for the ascidiozoids which emerge are independent, and it is only secondarily that they combine more or less intimately. No actual continuity was observed between the individuals. It may be that in spring there is direct budding, without the formation of statoblasts.

## INVERTEBRATA.

### Mollusca.

#### γ. Gastropoda.

**Structure of Runcino.**†—Guiseppe Colosi gives an account of the macroscopic and microscopic structure of *R. calaritana* sp. n.—a Tectibranch Gastropod. He demonstrates the presence of a gastric valve, a gastric gland, an unpaired "liver" with a single opening into the intestine, and a secondary kidney. The genital apparatus is quite unique. It is necessary to make within Tectibranchs a special section, Runcinidea.

#### δ. Lamellibranchiata.

**Larva of Oyster.**‡—J. L. Dantan has studied the early stages in the development of *Ostrea edulis*. The eggs develop in the pallial cavity, but the parent should not be called viviparous. The larva shows a neural plate, a preoral crown of cilia, a postoral wreath, and a medio-anterior zone. At the entrance of the gullet there are two ectodermic buccal glands. The stomach is divided by a constriction into a cardiac and a pyloric pouch. There are two hepatic vesicles. The larvæ ingest microscopic particles in the pallial cavity. Below the large cells of the preoral crown of cilia there are four nerve-masses united by very delicate nerves to the neural plate. The muscular system is much more developed than has been described. The fibrils are striated, but in contraction they assume the vermicular appearance believed to be characteristic of smooth muscle. The upper part of the larva corresponds to the cephalic portion of a trochophore; the ciliary apparatus and the nervous system are essentially the same in oyster-larva and trochophore: they both possess head-kidneys, and probably other transitory larval organs, the anal vesicles.

* Bull. Soc. Zool. France, xli. (1916) pp. 6–15 (5 figs.).
† Mem. R. Accad. Sci. Torino, lxvi. (1915) pp. 1–35 (18 figs.).
‡ Comptes Rendus, clxiii. (1916) pp. 239–42.

## Arthropoda.

### a. Insecta.

**Gametogenesis and Sex-determination in Gall-fly.***—L. Doncaster continues his study of *Neuroterus lenticularis* (*Spathegaster baccarum*). He has previously shown (1) that any individual female of the agamic generation produces either male or female offspring, but not both: (2) that the eggs of some agamic females undergo a reduction division at maturation, while those of others do not; (3) that since males have ten chromosomes in the germ-cells before maturation, while females have twenty, the eggs which undergo reduction produce males, and those which do not, produce females; (4) all eggs of the sexual generation undergo a double maturation division and are fertilized, giving rise to females of the agamic generation with twenty chromosomes in the ovarian cells. The agamic females appear in early spring; sexual females and males in early summer.

Experiment has shown that any individual sexual female has grand-children exclusively or almost exclusively of one sex. The galls produced by sexual females were sleeved, each sleeve containing galls derived from one female parent. In sleeves of galls derived from six females 4235 males and 83 females were bred, while in sleeves of galls from another set of six females there were 5139 females and 117 males. About half of the sleeves contained no exceptions, and it is suggested that the exceptions are due to eggs of wild flies laid through the meshes of the sleeves.

Two possible cytological causes might account for the fact that some sexual females produce only male-producing offspring and others only female-producing offspring. If each fly pairs only once, the difference might depend on the existence of two kinds of males, or it might arise through differences in the maturation-processes of eggs laid by the two classes of sexual female. No cytological difference in the spermatogenesis of different males could be detected. The maturation phenomena of the eggs (about 300) of fifteen separate females were examined, and while they seem to fall into two rather distinct types, the differences are not sufficiently considerable to correlate them with the sex-phenomena with any confidence.

The maturation-processes of the eggs are remarkable, and if, as seems probable, the peculiar figures are not due to methods of preservation, they differ widely from the ordinary type of mitosis. The first division takes place by the drawing out of threads (probably double) on each side of the nucleus; the reticulum becomes absorbed in these threads, which form two groups of parallel chromosomes on a spindle. These chromosomes then divide, probably longitudinally, giving rise to the group which forms the egg-nucleus and three groups of polar chromosomes.

**Spermatogenesis in Belostoma.**†—A. M. Chickering has made a preliminary study of spermatogenesis in *Belostoma* (*Zaitha*) *fluminea*,

* Proc. Roy. Soc., Series B, lxxxix. (1916) pp. 183–200 (2 pls.).
† Trans. Amer. Micr. Soc., xxxv. (1916) pp. 45–56 (3 pls.).

the giant water-bug which occurs in great numbers in the shallow pools and slowly-moving streams of Wisconsin. Nymphs and adult males, which were often found with egg-clusters on their backs, were used for the investigation. The spermatogonial number of chromosomes is twenty-four. Only general facts were determined as to synapsis and post-synaptic stages. During the post-synaptic period the double nature of the chromosome threads is evident. There is a "confused" stage just previous to the prophases of the first division. The "chromatoid bodies" appear in this "confused" stage for the first time. Proof that they originate from the cytoplasm is not lacking, because they are plainly seen outside of the nuclear membrane at this stage. Tetrads appear in the form of V's, rings, and rods, and all become dumb-bell shaped, by continued condensation, at the time that they enter the spindle. The first maturation division is an equational division. Polar views show thirteen chromosomes, which is one-half the spermatogonial number *plus* one. The chromatoid bodies are at their maximum size in this and the following division, and generally grow smaller from that point onwards. The interkinesis is of short duration. No nuclear vacuole is formed, the chromosomes maintaining their individuality throughout. When the chromosomes arrange themselves in the metaphase of the second division an entirely new arrangement is assumed, and an xy-pair of sex-chromosomes can be identified. Twelve chromosomes are delivered to each spermatid in the second division, one half receiving, in addition to the eleven ordinary chromosomes, an x-chromosome, and the other half a y-chromosome. The chromatoid bodies behave irregularly all along. Some spermatids have none, others have one, and still others in increasing proportions have two or three.

**Eugster Gynandromorph Bees.***—T. H. Morgan discusses these strange forms, whose male parts are maternal, while the female parts are paternal. It is suggested by Morgan that two or more spermatozoa may enter the egg, one uniting with the ovum-nucleus, and the other forming an independent centre of development. Newell has shown that drone bees inherit the characters of the mother. Boveri has suggested, in regard to the gynandromorphs, that delayed fertilization, or some irregularity in the entrance of the spermatozoon, might lead to the sperm-nucleus fusing with one of the two nuclei produced by the division of the egg. A third possibility is some dislocation during development of the two sex-chromosomes.

**Eggs and Early Stages of Parasitic Hymenoptera.†**—F. Silvestri describes the peculiarities of several types. The ova of *Encyrtus mayri* show mono-embryonic development and have no true cyst within the host. In *Encarsia partenopea*, the activity of the polar globules ends at the third cleavage and involution sets in; there is a constriction of the posterior pole where the germ-cells begin to differentiate when there are eight segmentation nuclei. In *Prospaltella* (*Doloresia*) *conjugata* the

* Amer. Naturalist, l. (1916) pp. 37–45.
† Boll. Lab. Zool. Scuola Agric. Portici, x. (1915) pp. 66–88 (6 pls. and 4 figs.).

polar globules have no appreciable period of activity, and the first germ-cell is seen at the fifth segmentation. In *P. berlesei* the oocyte of the first order shows no distinct oosome, and there is only one polar globule. In *Anaphoidea luna* the ovum has no oosome, the nature of the body called "nucleolus" is obscure, polar globules are formed in the parthenogenetic and in the fertilized ova, the germ-cells are not distinct until the end of the blastoderm stage.

**Polyembryonic Development.***—Patterson finds that in *Copidosoma gelechiæ*, a Hymenopterous parasite of the *Solidago* gall-moth (*Gnorimoschema gallæsolidagonis*), the egg gives rise to about 191 individuals. The egg divides into embryonic primordia. The polygerm divides into several spherical primary masses, and these into secondary masses. The larvæ destroy the soft parts of the caterpillar. As males and females emerge from the same caterpillar, it is probable that two or more eggs are laid in the same host.

**Sense-organs on Mouth-parts of Honey-bee.**†—N. E. McIndoo has shown that bees have likes and dislikes in regard to food, and that they discriminate keenly, e.g. between candies containing strychnine and those containing quinine. All foods scented with peppermint are repellent to bees. Lime-sulphur and kerosene are strong repellents. Among acids formic acid repels least and carbolic acid most. Various kinds of honey are distinguished.

Two general types of sense-organs were found on the mouth-parts, viz. innervated hairs and innervated pores ("olfactory pores"). The innervated hairs, spine-like and peg-like, are probably tactile exclusively. The pores are identical in structure with those on the legs, wings and sting.

The gustatory sense in bees seems only to be a phase of the olfactory sense. No sense-organs were found connected with the alimentary tract between the pharyngeal plate and the honey-stomach. The innervated hairs described are not suited for taste. Bees smell their food, but it is sometimes necessary to dissolve the food about the mouth before the odorous particles are given off. Perhaps it is most accurate to say that the highly developed olfactory sense in bees serves for olfactory and gustatory perception combined.

**Solitary and Social Wasps of Africa.**‡—E. Roubaud has made a very interesting study of tropical wasps, with special reference to the evolution of social life. 1. The first chapter is represented by some Sphegidæ and Pompilidæ. The mother-wasp paralyses victims, accumulates them for her larvæ, but has nothing more to do with the brood. 2. The second chapter is represented by some Eumenids of Tropical Africa. The mother brings paralysed booty day by day to the larva,

* Biol. Bulletin, xxix. (1915) pp. 333–72. See also Trans. Amer. Micr. Soc., xxxv. (1916) pp. 70–7.

† Smithsonian Misc. Collections, lxv. (1916) No. 14, pp. 1–55 (10 figs.).

‡ Ann. Sci. Nat. (Zool.) ser. 10, i. (1916) pp. 1–160 (32 figs.).

is in intimate association with it, and knows it as hers. 3. In the next stage the sting is not used for paralysing, only for defence. The booty is killed, made into pap, and laid beside the larva, the mother reserving a tithe for herself. Associated with this is a change in the mouth-parts of the larva, the masticatory apparatus being reduced and a sort of buccal funnel being formed. There is also supra-salivation, and the mother licks the secretion greedily. 4. The next step is a prolongation of the reproductive period and the simultaneous nurture of several larvæ. This means that more food is required, but it also means that there is more salivary secretion. What Roubaud calls an "œcotrophobiosis" is established, a nutritive exchange between larvæ and mother. The régime is arranged so that there is a succession of young larvæ, for only the young stages produce the attractive secretion. In warm countries the nest is kept up all the year round.

It seems likely that the social life of wasps arose, not by grouping, but by filial association, and many gradations are known. When young females emerge from the cocoons while the mother is continuing her maternal labours, there is an inducement for them to remain as her collaborateurs if there is abundant stored food available and plenty of salivary secretion on the part of young larvæ.

In the genus *Belonogaster* the queen may revert to a solitary régime in hard times. When conditions are better, but still not very good, her daughters may be insufficiently fed, and may almost become "workers." They are fertilized, but they are slow to lay. When conditions are thoroughly prosperous there are several functional females in the community. These polygynous nests are found only in warm countries, where nidification goes on without interruption. It is probable that the monogynous nest, with a single queen and with many workers more or less completely sterile, arose in Northern countries and in later times. Social wasps date from the Oligocene and Miocene.

Social evolution seems to have proceeded along two divergent lines among Hymenoptera. The one line is predatory, with its climax in the social wasps, with Eumenids and Pompilids remaining solitary. The Masaridæ, which do not paralyse booty and are vegetarian (eating nectar, &c.), both as adults and larvæ belong anatomically to the Vespiformia. The honey-storing régime finds its climax in hive-bees, with many solitary types and intermediate grades. The solitary Digger-wasps, like *Sphex*, which paralyse the booty that they store for their young, belong anatomically to the bee-line (Sphegiformia). It is probable that the melliferous régime is derived from the predatory, and that it arose in types where poison was not suitable for the preservation of flesh.

**Agaoninæ.***—G. Grandi gives an account of a collection of these Chalcidid Hymenoptera made by Silvestri in E. Africa. They are parasites of figs. Nineteen new species of *Blastophaga*, *Ceratosolen*, *Sycophaga*, *Apocrypta*, and other genera are described, and some of them are very striking forms, e.g. *Allotriozoon prodigiosum* g. et sp. n.

* Boll. Lab. Zool. Scuola Agric. Portici, x. (1916) pp. 121–286 (52 figs.).

**Stimulation of Hatching.***—Messrs. Severin and Hartung have tried to discover the stimuli which determine the hatching of the eggs of *Chætogædia monticola*, a Tachinid Dipteron. The eggs are laid on various grasses and weeds, and at the time of oviposition contain full-grown larvæ. The larva is a parasite in certain insects, e.g. caterpillars, which eat the vegetation on which the eggs occur. The problem is to account for the sudden hatching in the digestive tract of the host which permits the parasite to begin penetrating the wall before being expelled with the excreta. It seems that the digestive juices of the host, reaching the larva through the micropyle, stimulate it to perform the body-movements by which escape from the chorion is effected.

**Ichneumonid Parasite of the Plum-weevil.†**—R. A. Cushman describes the life-history of the ichneumonid *Thersilochus conotracheli* Riley, a very abundant and effective parasite of the plum-weevil, *Conotrachelio nenuphar* Herbst, the only insect which it is known to attack. It is single-brooded, reaches the adult stage in the autumn, and leaves its cocoon late in the following spring or early in the summer, the males beginning to appear a few days before the females. Parasitization takes place while the Curculio or weevil larva is very small, and before it burrows into the fruit beyond the reach of the parasite's ovipositor. The female thrusts her ovipositor into the tunnel made by the Curculio larva, and piercing the skin deposits within it a single egg. The larval parasite spends most of its time in its host, leaving it when nearly full-grown, and draining the last trace of fluid from without. It moults four times before leaving its host and constructing its cocoon, which is oval, and made of tough reddish-brown silk. Pupation takes place in four or five days after its construction, and the adult stage is reached about the end of August, the ichneumonid hibernating within the cocoon. The egg is oblong-oval, about 0·33 mm. in length, and under a magnification of 215 diameters does not show any sculpture of the chorion.

**Life-history of Blow-fly and House-fly.‡**—Winifred H. Saunders has observed the egg-laying, etc., in the Bluebottle (*Calliphora erythrocephala*), the Greenbottle (*Lucilia cæsar*), and the House-Fly (*Musca domestica*). In the Bluebottle, eggs laid on September 1st–2nd hatched on 2nd–3rd; the larvæ pupated on 14–15th; the flies emerged on the 27th. For the Greenbottle the corresponding dates were August 24th, 25th, September 4–5th, 15–29th. The Blow-flies lay their eggs parallel with one another in compact groups; the long sensitive ovipositor feels the surface before the passage of each egg. In hatching the egg splits longitudinally along a suture marked by a white line. No moults of the larvæ were discovered.

The eggs of the house-flies studied were laid on bananas, either in cracks or crevices of the pulp or under the loose skin. The maggots

* Psyche, xxii. (1915) pp. 132–7. See also Trans. Amer. Micr. Soc., xxxv. (1916) pp. 69–70.
† Journ. Agric. Research (Washington), vi. (1916) pp. 847–56 (1 pl.).
‡ Proc. Zool. Soc. London, 1916, pp. 461–3.

fed on banana and a mixture of bread, casein, and sugar moistened with water. No moults were seen. The higher the temperature the quicker the development, but 38° C. appears to be the limit. The period between egg-laying and the emergence of flies varies from 9 to 25 days. The eggs hatch the day after they are laid; pupation occurs in 6–16 days.

**Baits and Poisons for Flies.***—Olive C. Lodge concludes from numerous experiments that for Blow-flies, meaty substances make the best baits, especially blown liver. The digestive action of the maggots increases the attractiveness of the baits. For House-flies the most satisfactory baits consisted of mixture of casein, banana, and some sweet substance like treacle, to which sufficient water, beer, or stout is added to make paste. Formalin seems to remain the best poison for indoor use, in spite of its somewhat uncertain action. The best results were got with 2·5–7·5 p.c. pure formalin. The proportion of the sexes, it is noted, is nearly equal in House-flies.

**Flies and Manure.**†—Winifred H. Saunders has found after many experiments two very successful methods of treating stable manure so as to secure the destruction of flies. The first is the surface-dressing of the manure with green tar oil or with neutral blast-furnace oil and soil. The second is the application of tetrachlorethane. Both treatments successfully kill the maggots and are harmless to plants. The tar oil has a permanent effect in being resistant to rain, while the effect of the tetrachlorethane lasts only while the liquid vaporizes.

**Destruction of Flies.**‡—Winifred H. Saunders finds that flybane is effective in killing flies by contact, but does not act as a repellent; that exol brings flies down, but about 50 p.c. recover; that "Army Spray" successfully kills by contact, but is not a deterrent; that Berlese's flykiller (treacle, arsenic, and water) was not a success in Britain; that fly-papers were very successful; that of traps the common balloon is best. The trap should be baited with casein and sugar in equal parts (Mapweb bait), moistened with beer, stout, or banana. To keep rooms free from flies the most practicable procedure is to spray daily with Professor Lefroy's New Army Spray (harmless to food and having a pleasant scent), and to set fly-papers and traps.

**Study of Tychius 5-punctatus.**§—G. Grandi gives an account of the adult, ova, and full-grown larva of this Curculionid beetle. The straw-white, ellipsoidal eggs, with very delicate chorion, are laid in beans and vetches. The external features of the full-grown larva are dealt with, including the chætotaxis. The adults eat the leaves and young seeds; the eggs are laid in the seeds; the larvæ bore in the seeds. Practical preventives are discussed.

* Proc. Zool. Soc. London, 1916, pp. 481–518.
† Proc. Zool. Soc. London, 1916, pp. 469–79.
‡ Proc. Zool. Soc. London, 1916, pp. 465–8.
§ Boll. Lab. Zool. Scuola Agric. Portici, x. (1916) pp. 103–19 (6 figs.).

**Genital Appendages in Blue Butterflies.***—T. A. Chapman describes with great wealth of illustration the male and female appendages in the tribe Plebeiidi of "Blues" (Lycæninæ). He devotes particular attention to the correlation of the two sets of parts in pairing.

**Colour of Cocoons in Philosamia.**†—Onera A. Merritt Hawkes has studied the effect of moisture upon the silk of the hybrid *Philosamia* (*Attacus*) *ricini* ♂ and *P. cynthia* ♀. The wild forms of *P. ricini* have a pure white cocoon; the domesticated form has cocoons sometimes pale fawn, sometimes white. Those experimented with produced white cocoons. In *P. cynthia* the colour of the cocoon is typically red-brown, varying in intensity.

The larvæ of the hybrid moths may begin to spin with a white or a fawn silk. In all but two cases the white or fawn cocoons became various shades of red-brown when placed in a very moist atmosphere. This change can occur when the silk is removed from the cocoon, and is due to the effect of water vapour and not to atmospheric oxygen. No evidence indicated that the coloration is due to any excretion of the larva, and there is some negative evidence suggesting that excretion has no influence at all. Further research is needed to ascertain the chemical differences between brown and white silk. Further breeding is necessary to discover the causes to which the variations are due.

**Pink Coloration in Katydid.**‡—Hancock finds that when a pink female of *Amblycorypha oblongifolia* is crossed with a normal green male some of the hybrid progeny emerged after two years, others after three, and that nine were pink, four green. The sexes were about evenly divided in both the pink and the green forms. The $F_2$ generation has not yet appeared.

**Respiration in Aquatic Insects.**§—Frank Brochet adds to previous studies on aquatic insects an account of some experiments on *Dytiscus* and *Hydrophilus*. He finds that inspiration is active, and is due to a lateral contraction of the metathorax. Expiration is active, and is due to a dorso-ventral flattening of the metathorax. It is probable that, apart from the muscular action, the elasticity of the wall of the metathorax assists in respiration. The integument tends to resume its normal form, intermediate between that during expiration and that during inspiration. It is probable that most of the abdominal movements are only secondarily and distantly connected with respiration. A full account is given of the musculature.

**Notes on Indian Insects.**‖—T. Bainbridge Fletcher communicates a hundred notes on Indian insects. An incipient nest of an ant,

* Trans. Entomol. Soc. London, 1916, pp. 156-80 (45 pls.).
† Journ. Exper. Zool., xxi. (1916) pp. 51-60.
‡ Entom. News, xxvii. (1916) pp. 70-82. See also Trans. Amer. Micr. Soc., xxxv. (1916) p. 73.
§ Rev. Suisse Zool., xxiii. (1916) pp. 401-38 (1 pl.).
‖ Bull. No. 59, Agric. Research Inst. Pusa, 1916, pp. 1-39 (20 figs.).

*Œcophylla smaragdina*, was found with eight deälated females and a common mass of eggs and larvæ, without males or workers. Gynandromorphism is reported in a Lasiocampid moth, *Metanastria hyrtaca*: the wings and antenna on the right side are male, on the left side female. A butterfly (*Catopsilia*) was seen to be caught and eaten by a Drongo; four other cases were observed, but without identification of species. These are three examples of the author's interesting observations; the majority refer to injurious insects.

**Comparative Morphology of Zoocecidia.***—B. W. Wells publishes a paper in which he surveys the known insect and mite galls of *Celtis occidentalis*, a species of hackberry occurring in Ohio and Kansas. The paper has great interest, in that it deals comparatively with practically all the galls on one kind of plant, and with the normal tissue of the plant. A histological description of the gall-bearing parts of the plant in their normal state is given for comparison with the histology of the galls. The author defines a Zoocecidium as "a hypertrophy (abnormal enlargement of single cells) or hyperplasia (abnormal proliferation of cells) of plants, causally related to certain animal parasites." This definition covers all except those rare cases in which the normal tissue undergoes differentiation without apparent hypertrophy or hyperplasia. The etiological problem is dealt with only indirectly, and it is emphasised that the nature of the stimulus applied by the insect is not known. Experimental studies point to a chemical interpretation (enzymes, etc., secreted by the larva), but the chemical theory is as yet only a necessary inference, and is not definitely supported by experimental evidence.

There are seventeen known species of Zoocecidia occuring on *Celtis occidentalis*, and these belong to four orders of Arthropods: Acarina (1), Lepidoptera (1), Hemiptera (5), Diptera (10). All are heteroplasias—that is, those forms of hyperplasia in which the cells and tissues differ from the normal. All are built up on the basis of the same germ-plasm—that of the species of plant in question. The acarinous and lepidopterous galls are "kataplasmas," those forms of heteroplasias whose cells and tissues do not differ widely from the normal. Each shows specific and characteristic inhibition of differentiation. The hemipterous and dipterous galls are prosoplasmas, or those whose cells and especially tissues differ fundamentally from those of the normal parts. Each of these galls shows definite specificity. In the hemipterous forms the specific characters are in part related to the plant structure which bears the gall: in the dipterous galls the specific characters are wholly related to the specificity of the physiological phenomena associated with the species of larva concerned in the development of the galls. In the prosoplasmas the types of cells found are closely comparable to those of the normal plant parts, but the *tissue-forms* discovered are fundamentally new; no analogous structure-forms are to be found in the tissues of the normal plant or its allies. In the dipterous prosoplasmas, where the gall's specific tissue *form*-characters are related to the species of insect, there is an "overlapping" of the

* Ohio Journ. Sci., xvi. (1916) pp. 249–98 (8 pls.).

hereditary constitution of an animal on that of a plant, in the sense that factors associated with the insect determine the form-character locally, rather than those normally associated with the plant's germ-plasm. These latter plant factors suffer suppression.

In conclusion, the author suggests that zoocecidology affords a hitherto unrecognized field for the study of problems pertaining to the mechanism used in the expression of hereditary characters.

**Hessian-fly Parasites.***—C. M. Packard contributes a paper of much economic importance on the life-histories of three parasites of the Hessian-fly (*Mayetiola destructor* Say) and methods of rearing them. The species are *Eupelmus allynia* French, *Merisus destructor* Say, and *Micromelus subapterus* Riley. Parasites are the most effective factors in the control of the Hessian-fly, and the author says that "a thorough knowledge of the life-histories, field-habits, relative efficiency, and effective methods of artificial propagation and dissemination of the different parasites, therefore, might make it practicable to introduce the most efficient species from localities where they are abundant into other localities where the host is working destruction unchecked by its enemies." To this end methods of breeding and rearing the three species are given, and their life-histories are traced through the egg, larva, pupa, and adult. Figures are given of the eggs, pupæ, and larvæ, much enlarged, and of the mandibles of the full-grown larvæ, highly magnified.

**Position of Jassoidea.**†—Eric S. Cogan has made a morphological study of the super-family Jassoidea, small, or comparatively small, Homopterous insects which have prismatic hind tibiæ armed with a row of spines on their posterior margins. The super-family is divided according to the position of the ocelli and the venation of the elytra into Bythoscopidæ, Tettigoniellidæ, Jassidæ, and Typhlocybidæ.

Cogan finds that the Jassoidea can be homologized with the other Homopterous families. The head differs very little from the fundamental plan of the Cicada, and while the Jassid does not show the prominent sulci the mouth-parts are very similar. The mandibular setæ represent the mandibles; the maxillary setæ together with the maxillary plate constitute the maxillæ. The labrum and clypeus are scarcely distinguishable from one another; the epipharynx is closely related to the labrum. The tentorium is present, and the invaginations occur as in all insects. There is a well-developed salivary pumping apparatus. The epicranium is subject to some modification in size. There is a well-developed nervous system, almost entirely in the head and thorax. The digestive system agrees in the development of a food-reservoir with the other Auchenorrhynchous Homoptera. In general, the internal structure is that of a generalized Hemipteron, and the various modifications which occur are just as likely to be specific as well as generic.

* Journ. Agric. Research (Washington), vi. (1916) pp. 367–81 (2 pls.).
† Ohio Journ. Sci., xvi. (1916) pp. 299–322 (3 pls.).

**Notes on Species of Aleurodes.***—James Burton communicates some observations on a species of *Aleurodes*, probably *A. brassicæ*, which he studied on a fuchsia. The fly is almost exactly 1 mm. in length, and covered with a mealy exudation. The last segment bears on its dorsal aspect a peculiar structure. "It is formed of a short, hollow, crater-like base, from which projects a sort of papilla covered with hairs." (The author speaks of the "honey-dew" of Aphides being emitted from two tubes near the end of the body; but is not this an error?) The mealy substance consists of very short curved rod-like pieces. The yellowish larva moves feebly and throws out a fringe of filaments. It appears to increase in size, and develops a number of long glass-like brittle processes from the back and sides, and becomes a box-like pupa. The side of the box is composed chiefly of the wax fringe, and the sides of the box are ornamented with curved glass-like hairs. Out of the broken box the fly emerges.

**Hatching, Breeding, and Oviposition in a Mantis.**†—C. B. Williams and P. A. Buxton have made some observations of *Sphodromantis guttata* from Algeria. The eggs lie in groups in the middle of the complex ootheca, and each group of eggs has a passage to the exterior. Through these passages the young emerge, many at once. The vibration made by one young one perhaps excites those in the vicinity. The young Mantis appears head first and hangs down over the egg of the ootheca on a double thread secreted from two posterior papillæ. At no other stage is any thread or silk produced. The tergites of the meso- and meta-thorax and of the abdomen are covered, except for a narrow dorsal line, with very minute backward directed spines, which help in the early movements. There is a moult immediately after emergence. The changes in the form and habits of the young ones are described. A careful description is given of the structure and construction of the ootheca. Parthenogenesis does not occur.

**Inoculation of Locusts.**—E. Sergent ‡ describes experiments in Algiers in inoculating locusts (*Schistocerca peregrina*) with the American *Coccobacillus acridiorum*. No mortal infection results, and it is suggested that this may have been due to the presence in the locusts of two autochthonous bacilli which may have had an immunizing effect.

In another region M. Béguet § found that the locusts were susceptible at all stages to infection by the bacillus. About 10 p.c. in the field died of paralysis and diarrhœa. The infection spreads by cannibalism.

**Apterygota of Seychelles.**‖—George H. Carpenter reports on a collection of nine new Thysanura and fifteen new Collembola, besides

* Journ. Quekett Micr. Club, xiii. (1916) pp. 7–14.
† Trans. Entomol. Soc. London, 1916, pp. 86–100 (4 pls. and 3 figs.).
‡ Ann. Inst. Pasteur, xxx. (1916) pp. 209–24 (10 figs.).
§ Ann. Inst. Pasteur, xxx. (1916) pp. 225–42.
‖ Proc. Roy. Irish Acad., xxxiii. (1916) pp. 1–70 (18 pls.).

seven formerly-described species, from the Seychelles. The new genus *Corethromachilis* has a wonderful array of bristles on the lacinia of the maxilla and beneath the tip of each foot. Only two of the abdominal segments have two pairs of exsertile vesicles. The new genus *Microparonella* is primitive; it combines the distinctive Paronelline characters of the spring with the general aspect of an Entomobryine insect. Both these genera are peculiar to the Seychelles. A study of the Apterygota gives some indication that the latest continental connexion of the archipelago was with India and Ceylon rather than with Africa.

### δ. Arachnida.

**Tropical Fowl-mite attacking Man.***—Stanley Hirst notes that a blood-sucking mite which he described as *Leiognathus morsitans* sp. n., from the domestic fowl in several parts of Africa, the Comoro Islands, Mauritius, China, India, the Bahamas, and Columbia, is the same as that described by Berlese as *Liponyssus bursa* (there appears to be a slip of the pen in the tenth line of the paper) from Buenos Aires. Urich reports the mite from Trinidad; Cleland from Sydney. Hirst has previously recorded two cases of the mite attacking man; Cleland records the same from Sydney. The wide distribution of *L. bursa* is possibly due to this mite being carried about by the common sparrow. It seems that the European fowl-mite (*Dermanyssus gallinæ*) does not thrive in tropical and sub-tropical countries.

**False Scorpions of Britain and Ireland.**†—H. Wallis Kew adds to his previous synopsis a description of *Chelifer* (*Chernes*) *wideri* Koch, from Sherwood Forest, etc.; of *Chelifer* (*Chernes*) *powelli* sp. n., from Surrey, etc.; and of *Chthonius halberti* sp. n., from near Dublin. The list for Britain and Ireland includes thirteen species of *Chelifer*, *Cheiridium museorum*, five of *Obisium*, and five of *Chthonius*; of the twenty-four, Ireland has fourteen.

### ε. Crustacea.

**Orientation to Light in Porcellio scaber.**‡—H. B. Torrey and G. P. Hays have studied the rôle of "random movements" in the orientation of *P. scaber* to light. Their experiments led them to consider every orienting reaction phototropic whose direction is predictable in that it bears a definite relation to the source of light. *Euglena viridis*, species of blow-fly larvæ and earthworms, and *P. scaber* exhibit reactions of this type, which is not satisfactorily interpreted by the method of trial. *Porcellio* is easily guided in any desired direction by changing the direction of light falling on it from behind. The first locomotor movement made by *Porcellio*, when exposed suddenly to

* Ann. Nat. Hist., xviii. (1916) pp. 243-4.
† Proc. Roy. Irish Acad., xxxiii. (1916) pp. 71-85 (3 figs.).
‡ Journ. Animal Behaviour, iv. (1914) pp. 110-20.

light striking it at an angle of 90° with the major axis, was away from the light. The same pronounced negative reaction followed sudden exposure to light from the front at angles between 90° and 15°. When exposed suddenly to light coming from the front at angles less than 15°, *Porcellio* moved with less consistency away from the light: but its reactions were, on the whole, markedly negative. This lack of consistency was referred partly to the relatively large angular diameter of the source of light, partly to demonstrable inequalities in the sensitiveness of the two eyes of certain individuals to light. Details of three series of experiments are given in tabular form.

**New Species of Ichthyoxenus.***—Shigemi Ishii describes a parasitic Isopod, *Ichthyoxenus opisthopterygium* sp. n., found in the abdominal cavity of ten out of sixty-nine specimens of a fish (*Acheilognathus tabira*) from Lake Biwa. Like *I. japonensis*, the parasite is found enclosed in a membranous sac which lies freely in the body-cavity and opens by an orifice situated close behind the pectoral fin of either side. As the tissue of the sac apparently belongs to the host, and the parasite does not stand in direct contact with the viscera, it is not strictly accurate to say that it is lodged in the visceral cavity. The adults of both sexes and the larvæ are dealt with.

**Viguierella cœca.**†—P. A. Chappuis describes this rare blind Harpacticid, and compares it with *Phyllognathopus paludosus*, which seems to be another species of *Viguierella*. The processes of copulation and oviposition have been observed by Maupas, whose description is published in Chappuis's paper. The early stages of the life-history are described. It seems likely that *Viguierella* is of great phylogenetic age, as is suggested by the number of nauplius-stages, the separate genital apertures, the unpaired copulatory gland which represents the second testis, and the presence of a free first thoracic segment with the first pair of legs. There is an interesting pulsating apparatus in the maxillary gland, somewhat like that of *Bathynella natans*, which is also an antique form. The animal lives in dark mossy crevices, and may be ranked as a "troglophile." It does not need much water. It was, perhaps, in previous times an inhabitant of subterranean waters.

**Fresh-water Entomostraca from Ceylon.**‡—Robert Gurney describes *Oncocypris pustulosa* sp. n., from Ceylon, which is interesting as regards distribution, for the only other species of the genus is *O. costata* Daday, from East Africa. He also deals with *Physocypria tuberata* sp. n., very near *Cypris crenulata* Sars, *Diaptomus viduus* sp. n., represented by a single male among large numbers of *D. strigilipes*. Many known species are also recorded.

* Annot. Zool. Japon, ix. (1916) pp. 125–31 (10 figs.).
† Rev. Suisse Zool., xxiv. (1916) pp. 521–64 (2 pls.).
‡ Proc. Zool. Soc., 1916, pp. 333–43 (3 pls. and 1 fig.).

## Annulata.

**British Serpulids.***—W. C. M'Intosh gives an account of thirteen species:—*Protula tubularia*, *Filigrana implexa* (a very variable form), *Hydroides norvegica*, *Serpula vermicularis*, *Pomatoceros triqueter*, *Placostegus tridentatus*, *Apomatus ampulliferus*, *Ditrypa arietina*, *Spirorbis caulleryi*, *S. granulatus*, *S. borealis*, *S. pusillus*, *Pileolaria militaris*. The author also discusses a form of *Placostegus* from the 'Porcupine' Expedition, the coloration of *Cæsicirrus neglectus*, and the small *Cirratulus incertus* (which is figured), which was previously referred to as *C. bioculatus*, a preoccupied name.

**Notes on Indian Oligochæta.**†—J. Stephenson deals especially with collections from Ceylon and Cochin State. Two new genera are included: (1) *Erythræodrilus*, in a somewhat isolated position as a branch from the base of the Octochætine stock (*Howascolex* from Madagascar being its nearest relative and probably its immediate ancestor); and (2) *Comarodrilus*, a well-marked genus of the sub-family Megascolecinæ, related to other South Indian genera, such as *Woodwardia* and *Megascolides*. Another feature of the collection is the large number of new species. Thus of thirty-seven definitely named forms no fewer than twenty-five (twenty species and five varieties) are new. In the genus *Drawida* three out of four forms are new; in *Megascolides* all three, and in *Megascolex* twelve out of sixteen. With regard to the latter especially the impression left in the mind of the investigator is that in South India and Ceylon the genus has recently undergone a notable blossoming forth, with the production of a large number of forms and intermediate forms, and that in consequence it is extremely difficult to separate species from varieties, and varieties from examples of individual variability.

The author discusses the "pharynx" of Enchytræids—a flat raised plate of high columnar epithelium, with very definite edges, on the dorsal wall of the alimentary tube immediately behind the buccal cavity. The plate is perhaps sensory in function, and may be extruded for the purpose of exploration, or possibly also for picking up minute food particles by adhesion. That it can act as a sucker for help in progression is not likely.

In the description of *Fridericia carmichæli* reference is made to aggregations of setæ and setal fragments in the body-cavity in segments VII–IX, surrounded by masses of cœlomic corpuscles. They were present in all the specimens examined, and seemed to be in process of being eaten away. Perhaps they are formed in the way of excretion. The author also discusses the sperm-sacs in the genus *Enchytræus*, and the iridescence of the funnels of the vasa deferentia, which is due to the parallel arrangement of the spermatozoa.

* Ann. Mag. Nat. Hist., xviii. (1916) pp. 161–99 (1 pl.).
† Memoirs Indian Museum, vi. (1915) pp. 35–108 (4 pls.).

### Platyhelminthes.

**Cestodes from Poultry.***—John E. Gutberlet describes the structure of *Choanotænia infundibuliformis* (Goeze) from chickens. He corroborates his previous demonstration of the occurrence of the intermediate stage of this tapeworm in the common housefly (*Musca domestica*). The adult and cysticercoid stages are now dealt with, and four other species occuring in chickens—*Davainea tetragona*, *D. echinobothrida*, *D. cesticillus*, and *Hymenolepis carioca*. There are minute hooklets on the suckers and on the entire surface of the scolex of *Choanotænia infundibuliformis*. The blind tube which forms the uterus grows, forms pockets, and divides into small compartments. In *Davainea tetragona* the genital pores are irregularly alternate in the proglottids. The hooks on the rostellum of *D. cesticillus* vary from 8 to 12 $\mu$. The uterus appears as a solid cord of cells which becomes hollow, forms pockets, and fills the whole proglottis.

**Dipylidium caninum in Infant.†**—Maria Paz Mendoza-Guazon gives an account of a case of this tapeworm in the small intestine of an infant from Manila. The proglottids have a characteristic resemblance to melon seeds. The usual host of the tapeworm is dog or cat; the intermediate host is the louse or flea of dog or cat. Man is infected by being licked by the dog or cat, or from milk which the cat has licked, or by accidental ingestion of the intermediate host. Children are infected by putting their licked fingers into their mouths.

**New Frog Trematode.‡**—Sadao Yoshido describes *Enodiotrema rugocaudatum* sp. n., a small Distome from the intestine of *Rana nigromaculata*. It differs from the known species of the genus in the structure of the excretory system and cirrus-pouch and the large number of yolk-follicles.

**New Japanese Triclads.§**—Isao Ijima and Tokio Kaburaki describe a number of new Triclads and figure the reproductive organs. There are three new species of *Procerodes*, two of *Bdellocephala*, four of *Planaria*, two of *Polycelis*, and one of *Sorocelis*.

### Incertæ Sedis.

**New Phase in Life-history of Dicyemidæ.‖**—Aug. Lameere has inquired into the infection of cuttle-fishes with Dicyemids. It is not effected by the infusoriform phase, nor by the primary nematogenous

* Trans. Amer. Micr. Soc., xxxv. (1916) pp. 23–44 (4 pls.).
† Philippine Journ. Sci., xi. (1916) pp. 19–30 (3 figs.).
‡ Annot. Zool. Japon, ix. (1916) pp. 73–9 (1 pl.).
§ Annot. Zool, Japon, ix. (1916) pp. 153–71 (24 figs.).
‖ Comptes Rendus, clxiii. (1916) pp. 16–18.

phase, but by a phase antecedent to the latter. In *Dicyema truncatum* and *Microcyema vespa*, found together in young cuttle-fishes, a larval form gets into the urinary sac, fixes itself to the renal epithelium, and is transformed into the "nématogène fondateur." This gives rise to the primary nematogenous forms by a process identical with that which occurs in the multiplication of the vermiform phases.

The larva has the general appearance of the ciliated embryo of the nematogenous form of *Dicyema*, and the "nématogène fondateur" is like the nematogenous form, but it has three axial cells instead of one, the peripheral cells number twenty-eight, the polar cap cells eight, the parapolar cells three, not two. Near the last in the larva are some cells with corpuscles, probably of a nutritive nature, which disappear in the next phase.

The presence of three internal cells, disposed end to end, recalls a female Orthonectid. In a still younger larva each internal cell is represented, as in the female Orthonectid, by a cell-germ which forms the axial cell. So in the embryo of primary nematogens and rhombogens a primitive cell-germ forms the axial cell. The axial cell is to be interpreted as a parthenogenetic ovum, the main mass of which is the primitive cell-germ. The single polar body is reduced to a permanent nucleus, which remains under the vitelline membrane to form, with the vacuolized peripheral zone of the ovum, a follicle. The multiplication of the cell-germs followed by their segmentation is a case of polyembryony. Thus the peculiar phenomena exhibited by Dicyemids may be brought into line, save as regards the persistence and secondary utilization of the polar body.

The larva described is the infecting agent; it does not arise in the Cephalopod, but its origin (from some other host) is unknown. The infusoriform phase developed in the Cephalopod effects return to the primary host. It seems probable that the Dicyemid type has been evolved from the female Orthonectid, with the addition of a second parasitic phase.

**New Species of Ptychodera.***—W. J. Dakin describes *Ptychodera pelsarti* sp. n., from the Abrolhos Islands, west coast of Australia. It is the only species of the genus so far known from Australia. It is littoral, and occurs in very shallow water. The colour is pale yellow, the body is very translucent. The proboscis cavity shows the longitudinal muscles gathered into distinct radially arranged bundles. The neck of the proboscis contains a distinct well-developed but unlobulated "racemose organ." The ventral part of the proboscis, the cæcum, and the "racemose organ" are compressed laterally. The cornua of the nuchal skeleton are very long and reach the posterior half of the collar. The body of the skeleton has a characteristic shape. There are two proboscis pores. The stomochord has well-developed lateral pouches. The œsophageal region of the pharynx predominates over the branchial. The collar nerve-cord has a continuous lumen, and usually shows three dorsal roots.

* Journ. Linn. Soc. (Zool.) xxxiii. (1916) pp. 85–100 (2 pls.).

**Cribriform Cretaceous Polyzoa.***—W. D. Lang has revised the Cretaceous Polyzoa usually placed in *Cribrilina* and similar genera. As in other fossil Polyzoa, each form is a colony ("asty"), composed of individuals ("œcia"), incrusting other objects in free unilaminar or bilaminar sheets, in cylindrical tree-like forms, or sometimes in multilaminar masses. The œcia are Cribrimorphs and Steginomorphs, and are derived from Membranimorphs, or Cheilostome Polyzoa, with a box-like œcium, of which the uppermost side (front wall) has on it an oral rim (the "termen") which may be beset with spines. The termen includes the aperture. Outside the termen the skeleton is calcareous, within the termen it is chitinous. The evolutionary aim in the development of all families appears to be the disposal to the best advantage or least detriment to the organism of superfluous calcium carbonate. Ontogenetic stages of individual œcia can sometimes be seen at the growing edge of the colony, and the ontogeny may be used to corroborate the view taken of the phylogeny. Astogeny, or the growth of the colony itself, is a useful guide, and in fossil Polyzoa has this advantage, that each successive stage is left behind, and not, as a rule, covered over or obscured by further growth.

## Rotatoria.

**South African Bdelloids.**†—W. Milne describes *Monoceros falcatus* g. et sp. n. (the generic name will require rectification), type of a new family of Bdelloid Rotifers, having on the penultimate segment of the foot one spur only. There are four toes, each in a separate external sheath, and the rostrum is fully developed. The corona is inconspicuous or obscure. The jaws are abnormal. Two small circular arrangements, with not the slightest semblance of pedicels, situated on a prone face, represent the corona in *Philodina*. The gullet is extremely short. The most striking feature is the posterior aspect of the foot, with its four great sickle-shaped toes and the large spur, looking, when all planted downwards, as if supported on a banana-like bunch of props. The author describes *Didymodactylos carnosus* sp. n., nine new species of *Philodina*, and three new species of *Macrotrachela*.

## Echinoderma.

**Parental Care in Holothurians.**‡—H. Ohshima describes a hitherto unrecorded case of brood-caring in Holothurians. Among many specimens of *Pseudocucumis africanus* he found three which contained young, in all cases within the body-cavity of the mother. The young were all practically at the same stage of development, the size varying from 1·4 mm. by 0·6 mm. to 10 mm. by 2·5 mm. The colour was a light

* Ann. Mag. Nat. Hist., xviii. (1916) pp. 81–112.
† Journ. Quekett Micr. Club, xiii. (1916) pp. 47–84 (5 pls.).
‡ Annot. Zool. Japon, ix. (1916) pp. 121–4 (1 fig.).

greyish-violet, much lighter than in the adult. Their structure is described in detail. No primordium of genital organs was discovered. It was not possible to make direct observations on the fertilization of the ovum or on the way in which the young escape from the maternal body, but the author suggests that a single ripe ovum is produced at the free end of some of the genital tubes, and, after liberation into the body-cavity, is fertilized by spermatozoa which may have penetrated through the wall of the respiratory trees. The author refers to the view of Clark, who suggested, in connexion with *Chirodota rotifera*, that a temporary rupture of the body-wall might liberate the young; and of Becher, who indicated the abdominal pore, demonstrable in some species, as the probable way of escape.

### Cœlentera.

**Incubation in Actinia equina.*** — Ch. J. Gravier reports that most of the sea-anemones of this species, which he collected at San Thomé in the Gulf of Guinea, contained embryos and young forms at diverse stages. In some there was a large incubatory cavity below the gullet, packed with young. The largest, 12 mm. in diameter, had ninety-four mesenteries developed and had embryos inside it. This was also observed in other cases. There was no trace of sex-cells, and it may be that the embryos were of the same generation as the individuals that contained them, having entered them perhaps in the planula stage. But it may also be a case of asexual pædogenesis. In Europe the incubation of *Actinia equina* is not so prolonged as in the Tropics. A prolongation in boreal forms (*Rhodactinia* and *Actinostola*) is also known.

**Study of Species of Edwardsia.†** — Gilbert C. Bourne describes *Edwardsia mammillata*, *E. rugosa*, *E. vermiformis*, *E. rakaiyæ*, and *E. willeyana*, five new species collected by A. Willey in New Guinea. He also gives an account of the order of succession of the micro-mesenteries and tentacles in the Edwardsidæ, and in so doing brings forward reasons for regarding the Edwardsiaria as a group distinct from and of equal rank with the Zoanthinaria and the Dodecactiniaria. The outstanding feature in the growth of the Edwardsidæ is that, after the eight-rayed stage is reached, the mesenteries continue to be formed in *couples of singles*, and not in *couples of pairs* as in the Dodecactiniaria and Zoanthinaria. In short, the mode of development characteristic of the first four couples formed in the larvæ of Zoantheæ, Actinians, and Madreporaria is continued to the end in the Edwardsidæ, which thus retain a primitive mode of development and growth throughout their existence.

**Note on Tumularia.‡** — W. J. Robinson proposes the new name *Tumularia* for the forms at present placed in the genus *Stylaræa* See-

* Comptes Rendus, clxii. (1916) pp. 986–8.
† Journ. Linn. Soc. (Zool.) xxxii. (1916) pp. 513–30 (1 pl. and 2 figs.).
‡ Amer. Journ. Sci., xlii. (1916) pp. 162–4.

bach (1866), for this name is pre-occupied. The original generic description is as follows:—Vermicular, perforate sclerenchyma forming encrusting masses surrounded by a thin epitheca. Cells polygonal, moderately deep, with a strongly-developed spongy columella. Walls massive. Spines occur at the corners of the cells. Septa strongly crenulated; descending abruptly to the calyx floor. It is pointed out that *Tumularia* differs from *Protaræa* in having eight or sixteeen septa, not twelve; an essential columella instead of a parietal columella or none at all; and broad petalliform septa, not lamellar. The author calls it an Alcyonarian, and places it among the Heliolitidæ.

## Porifera.

**Factors in Evolution of Sponges.***—Arthur Dendy illustrates the suitability of the sponge phylum for the study of evolutionary processes. Many skeletal features can be interpreted as adaptive, others seem to have no sort of relation to the requirements of the organism. Many adaptive changes have been determined largely by mechanical conditions, e.g. in relation to the canal system and the gastral and dermal cortex. The forms of spicules are often adaptive, and "it really seems as if the sponge were able to do anything that may be required with the inherited material at its disposal, to convert a calthrops into a pitchfork, a grapnel, or an armour plate as occasion demands." On the other hand, the extraordinary forms assumed by so many of the microscleres of the Tetraxonida, all derivable from the primitive tetract, do not seem to have any adaptive significance. The same may be said of the chelæ of Desmacidonidæ. The reason for the existence of the divers forms of chelæ is a complete mystery: "we can only say that they must be, to use a mathematical expression, functions of heritable modifications in the constitution of the protoplasm of the germ-cells, the nature of which is as yet beyond reach of investigation, and that they are perhaps correlated with other characters which are of real value to the sponge." They probably originate as mutations. Peculiar characters, not of the nature of convergence, may occur in widely separated families. This may be illustrated by the discontinuous distribution of trichodragmata amongst the Tetraxonida. The trichodragma is a bundle of short, hair-like spicules, apparently all originating in one and the same mother-cell. A similar phenomenon is observable in the case of the microxea amongst Calcarea. "Discontinuity in the present distribution of trichodragmata and microxea almost certainly implies discontinuity in origin. Probably these spicules have arisen suddenly, and on many occasions, as the result of some unknown change in the constitution of the germ-plasm. It is, no doubt, more a chemico-physical than a biological phenomenon, and that, I believe, is true of all mutations." The author holds that the transformations of spicules suggest the existence of definite factors in the germ-plasm. The same view is suggested by the simplification which sometimes results by the complete dropping out of certain types of spicule. The Epipolasidæ of Sollas do

* Journ. Quekett Micr. Club, xiii. (1916) pp. 27–46.

not form a natural family, but consist of a heterogeneous assemblage of Stellettids which have independently lost their triænes.

The progressive evolution of the sponges as a whole has been a gradual process of increase in complexity of structure, due to colony formation and integration, in which branching and budding, folding and secondary fusing, have played the chief parts, while the skeleton has constantly become adapted to suit the new mechanical requirements. "Though species seem frequently to have arisen as mutations in trivial and non-adaptive characters, evolution, on the whole, seems to have taken place by a process of progressive evolution, in which mutation has played a comparatively small, though by no means negligible part."

**Notes on Aphrocallistes beatrix.***—Isao Ijima discusses this very variable species of Hexactinellid sponge, widely distributed in the Pacific, Indian, and Atlantic Oceans. Those in Eastern Asiatic seas have certain features in common, and may be designated *Aphrocallistes beatrix orientalis*. There is a somewhat diminutive development of macroscopic body-parts, and there are several characteristic features in the spiculation. Thus the dermalia are largely pentactine: the leptoscopules are always small, bulb-like, and beset with whorls of minute barbs; and there are elongate forms of hemihexasters not over 100 $\mu$ in length.

**Siberian Fresh-water Sponge.**†—Nelson Annandale describes *Spongilla* (*Euspongilla*) *arctica* sp. n., from some arctic lakes in north-western Siberia. The structure of the skeleton is peculiar and characteristic. It consists in the main of slender spicule fibres, each of which is encased in spongin. The fibres arise from the basal membrane, with which their investment is in direct continuity, and run upwards, sometimes in a slanting direction: in their course they branch frequently in a dichotomous manner, and delicate webs of spongin extend across the forks, often containing circular or oval apertures. Single spicules or indefinite transverse fibres run occasionally from one branch to another, carrying with them the investment of spongin. In addition to the organized skeleton, there are numerous loose megascleres lying free in the substance of the sponge and forming an irregular layer at the base. They are particularly numerous in the neighbourhood of gemmules, and sometimes form regular cages either round single gemmules or round groups of gemmules. These cages consist of spicules lying more or less parallel to one another in a membrane of spongin. In these skeletal features the new species seems to resemble *Ephydatia olchonensis*, from Lake Baikal.

## Protozoa.

**Soil Protozoa.**‡—T. A. Goodey describes a number of Protozoa from agricultural soil. The first is *Prowazekia* (*Bodo*) *saltans* Ehrbg., a bean-

* Annot. Zool. Japon, ix. (1916) pp. 173–83.
† Mem. Acad. Imp. Sci. Petrograd, xxviii. (1915) No. 9, pp. 1–3 (4 figs.).
‡ Proc. Zool. Soc., 1916, pp. 309–32 (4 pls. and 1 fig.).

shaped Flagellate, with two flagella, a kinetonucleus, a spasmodic jumping motion, and longitudinal division. The second is *Tetramitus spiralis* sp. n., a pyriform Flagellate, with four flagella arising from blepharoplasts, and longitudinal division. The new flagella are formed by outgrowths from the body, and not by splitting of the old flagella. The third is *Spironema multiciliatum* Klebs, which Klebs suggested might be a connecting link between Ciliata and Flagellata. The organellæ at the anterior end may be equally well regarded as long cilia or short flagella. A circular karyosome of deeply staining chromatin is embedded in the centre of the long narrow rod-like nucleus. The fourth is *Amœba lawesiana* sp. n., which the author distinguishes from Dobell's *A. glebæ*; and the fifth is *A. agricola* sp. n., with a modified mitotic division different from that in any other amœba.

**Strombidium mirabile.***—E. Penard gives an account of this beautiful new species of Ciliate, which he found near Geneva. It has a "carapace" of hexagonal plates, probably composed of a substance allied to cellulose. The author discusses the trichocysts and their explosive expulsion; the included Chlamydomonad algæ; the granules of the cytoplasm; the macronucleus and the micronucleus; the membranelles and the peristomial field; and the process of fission. Apart from fission there is an interesting internal adoral embryonic sac or bud, which is eventually set free.

The new species is closely allied to Anigstein's marine species, *Strombidium testaceum*, but the latter has a horse-shoe nucleus, is surrounded by a spiral of roughnesses or bristles, and has the trichocysts in a spiral. Perhaps the nearest affinities of the genus are with the Hypotricha.

**Regulation in Vorticella.**† — E. M. Runyan and H. B. Torrey, starting from the well-known fact that, in regeneration, one part of an organism may exert a measurable influence over the growth and development of another, have made observations and experiments which show that such a domination of one part over another exists also in *Vorticella*. The development of the stalk appears to be dependent on contact at the aboral end; while the development of aboral cilia is conditioned by physiological isolation from the stalk, whether achieved experimentally or by a narrowing of the protoplasmic connexion in the ordinary course of fission.

**New Species of Loxodes.**‡—Elton R. Darling describes what seems to be a new species of this genus of Holotrichous Ciliata. It is found in great numbers among Oscillaria, associated with *Nassula*, *Paramecium*, and Rotifers. Its food consists chiefly of small specimens of *Paramecium*. It swims in a spiral to the right. The anterior end is hook-like, but without a rostrum.

* Mem. Soc. Phys. Hist. Nat. Genève, xxxviii. (1915) pp. 227–51 (1 pl.).
† Biol. Bull., xxvii. (1914) pp. 343–5 (8 figs.).
‡ Trans. Amer. Micr. Soc., xxxv. (1916) pp. 64–5.

**Study of Triconymphidæ.***—Carlos França contributes some observations on these curious Protozoa. He deals first with *Triconympha agilis*, found by Leidy in 1877 in *Termes flavipes* in North America. It also occurs in *Leucotermes lucifugus* in Italy and Portugal. In the same insect there is another type, *Leidya metchnikovi* g. et sp. n., which Leidy regarded as a young form of *Triconympha agilis*. It has an elongated shape, with a delicate anterior end. There are flagella over the whole surface in a double spiral. At the anterior end there is an elongated siderophilous structure, on which small filaments are inserted like the barbs of a feather. These bear the anterior flagella. The siderophilous structure bifurcates posteriorily, and forms a double basis for the innumerable flagella covering the surface. There is a single relatively large nucleus with very compact chromatin. França recognizes the order Hypermastigina of Grassi and Foa, and four families—Calonymphidæ Grassi, Lophomonadidæ Grassi, Triconymphidæ Leidy, and Holomastigidæ fam. n. (including *Pseudotriconympha*, *Holomastigotoides*, and *Leidya*).

**Giardia from Meadow-mouse.**†—C. A. Kofoid and E. B. Christiansen describe *Giardia microti* sp. n., from the intestine of *Microtus californicus*. The new species differs in appearance, proportions, and stainability from the widely-prevalent *Giardia muris*. Abundant material was secured in various stages of binary and multiple fission and in encystment, including the so-called "copulation cysts," and cysts in which multiple fission had produced a 16-nucleate plasmodium or somatella. The organism (a binucleate somatella) shows the extranuclear organellæ known in other species. The neuromotor apparatus consists of a rhizoplast passing from the karyosome through the centrosome at the anterior pole of the nucleus, thence to the blepharoplast of its side of the axostyle. From or near the blepharoplasts arise three pairs of flagella.

**Fission in Giardia muris.**‡—C. A. Kofoid and E. B. Christiansen have studied binary and multiple fission in this parasite from grey and white mice and in *Peromyscus*, in which it causes chronic enteritis, especially in young hosts, with inflation and yellowish discoloration of the intestine.

The normal trophozoite has a single axostyle, not two, as heretofore stated, an integrated neuromotor apparatus with fibrillar connexions joining the karyosomes, centrosomes, blepharoplasts, flagella, parabasal bodies, and axostyles of the two cells in one more or less continuous system.

Binary fission occurs abundantly and normally, with delayed plasmotomy. Normal mitosis occurs with an intranuclear spindle, and four chromosomes in two groups. Precocious splitting of chromosomes in the prophase is followed by their fusion into a split skein, from which the four chromosomes emerge on the equatorial plate. The blepharoplast and axostyle lead in mitosis.

* Ann. Inst. Pasteur, xxx. (1916) pp. 195–204.
† Publications Univ. California (Zool.) xvi. (1915) pp. 23-9 (1 fig.).
‡ Publications Univ. California (Zool.) xvi. (1915) pp. 30–54 (4 pls. and 1 fig.).

Multiple fission is of three types:—1. Free individuals form a plasmodium-like somatella of eight fully equipped zooids, in the formation of which the duplication of organellæ keeps pace with nuclear multiplication. 2. Free individuals form eight zooids, but nuclear multiplication precedes the division of the organellæ. Encystment may follow. 3. Encysted single individuals form eight-zooid, sixteen-nucleate plasmodial masses with chromatic disintegration of organellæ, the axostyles persisting longest. The small free zooids are not to be confused with *Hexamitus muris*, which is a distinct species. No evidence was found of an "*Octomitus*" stage of *Giardia*.

There is tentative evidence of the fusion of two free individuals and also of copulation cysts, which may be derived therefrom with the two gametocyte individuals back to back, and of their maturation by two divisions. Chromosome reduction has not been detected in these divisions.

The most striking feature of the development of the free, sixteen-nucleate, eight-zooid plasmodium, or somatella, is the preservation, in each successive step of the process, of the fully equipped binucleate individuals. The individuality of the potential zooids is morphologically established and maintained; and there is evidence also of their functional independence in the independent motor struggles of each, which result ultimately in plasmotomy. In the cases of multiple fission in cysts and free individuals in which nuclear multiplication outruns that of the other organellæ, this individuality is more or less disrupted, or even lost. The possibility that some of these, at least, may represent involution or pathological states on the part of the parasite itself, should be borne in mind in all attempts to unravel the baffling significance of these protean aspects of this most interesting, suggestive, minute, but by no means simple organism.

**Species of Malarial Parasites.***—E. J. Marzinowsky discusses the various species of *Plasmodium*, and establishes *P. caucasicum* sp. n., which is characterized by peculiarities in the merozoites and annular forms, and by the schizogony in the peripheral blood. He contrasts it with *P. præcox*, *P. malariæ*, *P. vivax*, and *P. tenue* (?), and points out that the occurrence of different species may explain the clinical diversity of cases of malaria.

**Hæmoparasites of Chronic Fever.**†—A. I. Fedorovitch found in the peripheral blood of a fever patient from the Black Sea coast a number of oval, spherical, and irregularly-shaped free parasites. Most of them had one end drawn out into a thread. The nucleus was sometimes central, sometimes near the thread-like extremity. It was rounded or oval, in exceptional cases elongated or curved. The parasites varied from 2–7 $\mu$ in their greater diameter. They approached the forms (from a Cinghalese with chronic fever) which Castellani has called *Toxoplasma pyrogenes*, but their position among Protozoa is uncertain. An analogous form was found in 1905 from the blood of a dog from the Black Sea coast which also suffered from fever.

* Ann. Inst. Pasteur, xxx. (1916) pp. 243–8 (3 pls.).
† Ann. Inst. Pasteur, xxx. (1916) pp. 249–50 (2 pls.).

**Study of Crithidia leptocoridis.***—Irene McCulloch has studied this Flagellate, which abounds in the intestinal tract of *Leptocoris trivittatus*, the box-elder bug. In the vegetative stage it is a relatively long, slightly flattened form, tapering to fine points anteriorly and posteriorly. In the central part of the very hyaline cytoplasm there is a large vesicular nucleus connected directly with the extranuclear organelles, the rhizoplast, "kinetonucleus," flagellum, basal granules, and the "axostyle." Like others of its kind, it moves vigorously; the flagellum, the body, and the undulating membrane, all assist in progression. There is a very rapid vibration of the rigid body from side to side, combined with spiral movements of the flagellate end of the body, either to the right or to the left. Then an instant follows in which the spiral movement alone is in evidence. An instant later the flagellate end whips around and the organism darts off in another direction. The parasites were seen boring their way for at least one-third of their body-length into the Malpighian tubules.

The author describes the longitudinal binary fission of the vegetative phase. The life-cycle is divided into three stages: preflagellate (in the stomach), flagellate (vegetative forms in mid-intestine), and post-flagellate (in the rectum). The box-elder bugs seem to be casually infected by means of spores or moist excreta taken up with their food, which consists of the juice of the box-elder and maple-trees, and the fruit of the raspberry. Under laboratory conditions, when food was scarce, a vigorous insect has been seen sucking the digestive tract of a weakened one. There was no evidence of infection of eggs. The percentage of infection increases with age, and almost all adults are infected.

* Univ. California Publications (Zool.) xvi. (1915) pp. 1–22 (4 pls. and 1 fig.).

# BOTANY.

## GENERAL,

### Including the Anatomy and Physiology of Seed Plants.

#### Structure and Development.

##### Vegetative.

**"Sanio's Bars" in Pinus.***—W. Rushton has reinvestigated the development of "Sanio's Bars" in order to discover their origin. Twenty-five species of *Pinus* were examined, but the present results are based upon *P. Inops*, which exhibited the largest number of bars and gave the clearest results. The bars are small rods passing through the tracheides, cambium and phloem elements; in the cambium they are thin and solid, but in the phloem and xylem they are more or less hollow. They become thicker by deposits of layers of the substance of the cell-wall, i.e. cellulose in the cambium and phloem, lignified material in the xylem. They possibly have their origin in the small masses of protoplasm which frequently surround them in the cambium cells.

**Anatomy of Piper.**†—R. E. Hoffstadt has studied the vascular anatomy of *Piper methysticum* in order to give "a modern interpretation to the vascular structure, and to ascertain whether the stem keeps pace with the gametophyte of the group." The stem has two systems of bundles, i.e. a single-layered peripheral system and two rows forming a medullary system. The peripheral bundles are either large and primary or small and secondary, the latter being branches of the former. The bundles are of foliar origin and of collateral, endarch structure; after entering the stem they traverse the periphery through one internode, and the pith through two internodes. Both peripheral and medullary bundles show anastomoses. The pericycle is represented by a few lignified cells outside the bundles; there is no differentiated endodermis. Increase in thickness of the stem is due to cambial activity in the pith: interfascicular cambium appears late in the internodes, and still later in the nodes: it cuts off segments only on one side. Leaf-traces are numerous; the base of the leaf is sheathing, and the vernation is involute. The buds vary in number and position.

*Piper umbellatum* is found to differ from *P. methysticum* in having (1) Only one ring of medullary bundles; (2) mucilage-canals running

* Ann. Bot., xxx. (1916) pp. 419–27 (4 figs.).
† Bot. Gaz., lxii. (1916) pp. 115–32 (23 figs.).

through the centre of the stem and node ; (3) bundles running through one internode in the periphery and one in the pith before fusing with those of the leaf above. Both species have their stems, especially when young, richly stored with starch, piperin and mucilage ; neither of them has growth-rings. According to a recent theory the primitive angiosperms were woody, and the tendency towards herbaceous habit is modern. These forms show a tendency toward elimination of secondary growth and a breaking up of the woody cylinder in the following characters : (1) The pericycle is broken and all that remains is a small patch outside of each bundle : (2) the interfascicular cambium appears late in the internode, and still later in the nodes ; when it does occur the activity is primarily on one side ; (3) there is a tendency toward the scattering of the bundles in the pith. These characters, together with the sheathing base of the petiole, the multilacunar type of node, anastomosing of the bundles at the side, indicate a monocotyledonous tendency. Moreover, the embryo-sac of the group shows the elimination of one division in oogenesis.

One may conclude from this combination of characteristics that *P. methysticum* and *P. umbellatum* lie in a group well toward the level of Monocotyledons, and this conclusion is borne out by the female gametophyte.

**Anatomy of Drimys.***— E. C. Jeffrey and R. D. Cole have made experimental investigations as to abnormalities in *Drimys colorata*, *D. axillaris*, *D. Winteri* and *D. aromatica*. It has been found that as a result of injury "peculiar tracheary structures" are developed in the root. These structures appear to be abortive, and may be regarded as a reversionary return of the vessels formerly found in this genus. These traumatically induced structures "are characterized by the opposition and fusion of rows of pits," thus differing from ordinary tracheides : they lack, however, the perforations of normal vessels. The authors believe that in spite of the absence of perforation these structures give indication of vessels in the ancestors of *Drimys* and similar forms of the Magnoliaceæ. The rays and these traumatically formed structures point to the primitive position of *Drimys* among the Magnoliaceæ.

**Anatomy of Xerophytic Grasses.†**—E. Breakwell has studied the anatomical structure of the grasses of Australia with special reference to their adaptation to xerophytic conditions. The present work gives a brief description of the habitat, form of growth, and leaf anatomy of eleven species, and the following are the conclusions based upon these descriptions. *Spinifex hirsutus* is specially adapted for the storage of water. The hypoderma is greatly reduced, the parenchyma-cells are large and colourless, and the xylem-cells are very large ; on the other hand, the epidermal cells have narrow lumens and are well protected by hairs, especially in the neighbourhood of the depressed stomata. In *Astrebla pectinata* the hypoderma is better developed and serves to aid in the mechanical strengthening of the leaf, and to repress transpiration ;

* Ann. Bot., xxx. (1916) pp. 359–68 (1 pl.).
† Proc. Linn. Soc. N. S. Wales, xl. (1915) pp. 42–55 (12 figs.).

there are characteristic bands of colourless parenchyma-cells, probably utilized in assimilation; the stomata are not depressed. *Themeda arenacea* has stiff, rigid leaves, owing to the extremely well-developed hypodermal fibres; the bulliform cells are well marked. The chief xerophytic features of *Panicum flavidum* are dorsal stomata, bulliform cells, well-developed hypoderma, large and numerous xylem elements. *P. decompositum* is less xerophytic than the previous species, and is the only Panic-grass examined having bands of colourless parenchyma for aiding assimilation. *P. leucophæum* is still less xerophytic; the hypoderma is poorly developed, the bundles are small, and the bulliform cells less well marked. The least xerophytic of these Panic-grasses is *P. Benthami*. In *Neurachne Mitchelliana* the chief xerophytic features are a well-developed hypoderma, the large number of primary bundles, bulliform cells, the position of the stomata, the presence of trichomes. *Chloris acicularis* presents typical xerophytic features in the development of the hypoderma, in the bands of colourless parenchyma cells, the position of the stomata, and in the bulliform cells. *Eragrostis lacunaria* has trichomes, bulliform cells, and a well-developed hypoderma; *E. curvula*, a cultivated species, has similar characters, but the hypoderma and xylem elements are better developed, probably owing to the necessity for giving rigidity to the very long leaf.

**Bordered Pits and Ascent of Sap.***—I. W. Bailey has studied the bordered pits of Conifers in order to ascertain if the membranes form complete septa entirely impervious to finely divided solids and undissolved gases. Numerous sections of the wood of *Larix* and *Sequoia* were examined, and it was found that the membranes were clearly perforated, but the detailed structure was obscured by the overhanging walls. Aqueous solutions containing finely divided carbon could be made to pass freely through the membranes. The presence of perforations was also indicated by the fact that large quantities of gas could be forced through the pits of tracheides already saturated with sap. The surface tension of sap in the pit-membranes is proved to be less than three atmospheres. The tension hypothesis, according to which a pressure of five to twenty atmospheres is required in order to maintain continuous columns of water in trees, is thus shown to be untenable.

### Reproductive.

**Embryogeny of Cooperia.**†—M. B. Church has studied the development of the embryo-sac and embryo of *Cooperia Drummondii*. The writer finds that the primitive archesporial cell is of hypodermal origin, and develops at the expense of the nucellus into a large oblong cell. No tapetal cells could be found. Megaspore-formation was of the type usual for the Liliaceæ, and it seems probable that reduction-division occurs with the division of the one-celled stage. By division of the

* Bot. Gaz., lxii. (1916) pp. 133–42 (1 pl. and 2 figs.).
† Bull. Torrey Bot. Club, xliii. (1916) pp. 397–405 (2 pls.).

four nuclei an eight-nucleate sac is formed. At the time of fertilization the egg-cell is large and pear-shaped with a large, round nucleus; the antipodals when stained show signs of disintegration and have a marked tendency to enlarge; the nucellus has been absorbed except in the region of the micropyle; the two polar nuclei fuse, and triple fusion has also been observed; the synergids entirely disappear. Subsequent to fertilization the endosperm-nucleus undergoes mitotic division, giving rise to free nuclei; the latter are subsequently enclosed in cell-walls to form multinucleate cells. The fertilized oospore gives rise to a two-celled embryo, the basal cell of which develops into a suspensor and the terminal cell into the embryo proper.

The mature embryo has a long, spindle-shaped, succulent cotyledon projecting into the endosperm, where it absorbs food like a haustorium. The number of rudimentary leaves varies according to the conditions of growth, and the leaf-base is always closed. The primary root has a well-developed root-cap. The entire development appears regular when compared with the near relatives of this species.

**Embryogeny of Capsella.***—R. Souèges contributes a note upon the first divisions of the egg-cell and the origin of the hypophysis in *Capsella Bursa-pastoris*. The author finds that the basal cell of the pro-embryo divides transversely to form two daughter-cells, the lower of which again divides and gives rise to a large micropylar vesicle and a portion of the suspensor filament; the upper, or intermediate, cell of the pro-embryo has meanwhile divided to form the greater part of the suspensor-filament and the hypophysis cell. The apical cell divides vertically, and forms the true embryonic cell. Thus it appears that the intermediate cell does not originate in the apical cell, as is supposed by some authors, but arises from the basal cell and the bicellular pro-embryo.

## General.

**Supposed Origin of Life.†**—S. G. Paine has repeated the experiments of Bastian, in order to test the claim of the latter to have discovered the origin of living organisms from non-living materials. Eighty-five tubes of colloidal silica were subjected to the treatment recommended by Bastian, and the amorphous deposit which collected at the bottom of the tubes was carefully examined. Forms somewhat resembling organisms were found, but proved to be composed of silica. These forms appear to be the so-called "fungus-germs" which were regarded by Bastian as evidence of spontaneous generation of life. The present work shows them to be "purely inorganic simulacra formed by a slow deposition of silica from colloidal solution, and, in part, depositions of silica upon dead fungal hyphæ which had developed in the solutions before these were filled into the tubes and sterilized."

* Comptes Rendus, clxiii. (1916) pp. 158-60.
† Ann. Bot., xxx. (1916) pp. 383-88 (1 pl.).

## CRYPTOGAMS.

### Pteridophyta.

(By A. Gepp, M.A., F.L.S.)

**Branched Prothallia in Polypodiaceæ.***—Elizabeth D. Wuist gives a description and figures of branched prothallia cultivated from spores of various ferns. Her summary of results is as follows:—1. Branched prothallia occurred in cultures of *Adiantum bellum*, *A. capillus-Veneris*, *A. cardiochlæna*, *A. cuneatum*, *A. trapeziforme*, *Asplenium bulbiferum*, *A. Filix-femina*, *A. platyneuron*, *Camptosorus rhizophyllis*, *Onoclea sensibilis*, *Phegopteris polypodioides*, *Pteridium aquilinum*, *Scolopendrium vulgare*, *Woodsia obtusa*, *Woodwardia virginica*. 2. Branched prothallia were not confined to one type of culture medium, but developed on distilled water, on soil, and on nutrient solutions. 3. Branches were not developed at any definite period in the life-history of the prothallia, but were formed: (*a*) by any cell of the filament; (*b*) by divisions of the last cell of the filament; (*c*) from the margin and apex of the expanded portion of the prothallium. 4. Branching was both dichotomous and monopodial. 5. A definite relation seemed to exist between branching and nutrition.

### Bryophyta.

(By A. Gepp.)

**Treubia insignis.**†—D. H. Campbell gives an account of the structure of the archegonium and sporophyte of *Treubia insignis*, a plant which is usually regarded as connecting the acrogynous leafy Jungermanniaceæ with the typical anacrogynous forms—*Fossombronia*, *Petalophyllum*, *Noteroclada*. The character of the leaves, the apical cell, and the groups of archegonia bring *Treubia* near to the Acrogynæ; and possibly the dorsal lobes may be the homologue of the dorsal lobe of the leaves of *Madotheca*, *Frullania*, etc. The author puts forward the hypothesis that the line *Fossombronia*, *Petalophyllum*, *Noteroclada*, *Treubia* is a direct development of the *Sphærocarpus* type, through *Geothallus*: and that from this line some of the Acrogynæ may have originated. In this case the *Fossombronia* group would have to be removed from the *Pellia* line (Codoniaceæ) to the Sphærocarpales.

**Fossil Moss from Coal Measures.**‡—O. Lignier has found a single section of the stem of a moss, in a silex at Grand' croix, near Sainte Etienne. He calls it *Muscites Bertrandi*. The section passes through the base of a leafy stem, of which unfortunately all the internal paren-

* Bull. Torrey Bot. Club, xliii. (1916) pp. 365–83 (figs.).
† Amer. Journ. Bot., iii. (1916) pp. 261–73 (figs.).
‡ Bull. Soc. Linn. Normandie, vii. (1914) pp. 128–31 (1 fig.). See also Bot. Centralbl., cxxxii. (1916) p. 172.

chyma has disappeared. The superficial tissue is, however, sufficiently well preserved to allow of determination. The layer of external cells coarsely resembles an epidermis. On it are inserted here and there rhizoids. All the transverse walls, except a few at the base, are very regularly and clearly oblique. This peculiarity characterizes the present-day rhizoids of the Muscineæ. The internal stratum consists of larger, more regular cells. The presence of *Muscites Bertrandi* in the Stéphanien of Sainte Etienne helps to support the determination of certain vegetable imprints in the Stéphanien at Commentry, which Renault and Zeiller have attributed to *Muscites polytrichaceus*.

**Trichostomum Hammerschmidii.***—A. Hammerschmid describes thickenings on the wall of the capsule in *Trichostomum Hammerschmidii*, *Didymodon rubellus*, and *Barbula fallax*. In many cells of the epidermis of the capsule he noticed drops of oil in places where there was no thickening of the outer membrane. The habitat was shady and ver damp. Evidently the mosses wished to protect themselves from th excessive damp, and formed oil in the epidermal cells in order to drive out the water. When this object has been attained, the superfluous oil oozes out and hardens on the surface, forming globular thickenings. In dry seasons no oil is to be seen.

**Hungarian Bryophyta.**†—I. Györffy and M. Peterfi publish critical notes and figures in connexion with the "Exsiccatæ of Hungarian Bryophytes, edited by the Botanical Section of the National Transylvanian Museum." The authors remark on the extreme difficulty of obtaining the earlier Hungarian Exsiccatæ, issued by Fuss, Barth, Graschik respectively. The publication here in question is only published in thirty examples. From the notes on the first volume, the following details may be mentioned: *Clevea hyalina* Lindb. is much more rare in the region than *Sauteria alpina* Nees, or *Peltolepis grandis* Lindb. A minute description is given of *Bucegia romanica* Rad., which has also been found in North America by Brinkman. Two forms of *Molendoa Sendtneriana* occur—f. *lucifuga* in deep, easily divided tufts; f. *lucigena* in small, more compact tufts. The European Schistidieæ are all very closely related. *Schistidium brunnescens* Limpr. is regarded as allied to *S. astrofuscum* Limpr., not to *S. apocarpum*, *S. confertum*, *S. gracile*. *S. apocarpum* var. *intercedens* Schiffn. equals *S. brunnescens*, and is not an intermediate form. At present no intermediate form is known between *S. brunnescens* and *S. astrofuscum*. *Grimmia anodon* is regarded as a *Grimmia*, not a *Schistidium*. *Splachnum sphæricum* occurs plentifully in the Tatra over 2000 m. In lower levels *S. ampullaceum* is also common. *Dichelyma falcatum* Hedw. is found fruiting in many localities in the lakes of the Restyezát Mountains. Details of anatomical structure are represented in the plates.

* Mit. Bayer. Bot. Ges. München, iii. (1915) pp. 215–16. See also Bot. Centralbl., cxxxii. (1916) p. 144.

† Bot. Múzeumi Füsetek, i. (Koloszvár, 1916) pp. 10–73 (pls.). See also Bot. Centralbl., cxxxii. (1916) pp. 269–70.

**Vegetation of Tatra Caves.***—A. J. Zmuda has examined systematically the vegetation of thirteen caves in Tatra and of two in the Karste. The largest number of mosses are found in caves in which the diffused light is equal to $\frac{1}{1100}$. The damper the cave, the richer is it in Cryptogams. The flora is not adversely affected by low temperature provided it is fairly constant Some species of mosses show a variety of elevation between their limit in the open and in caves—for example, *Neckera Besseri*. 990 m. in the open, 1390 m. in caves. In the fight for existence certain species habitually go under. Acrocarpous species are often crowded out by pleurocarpous. Many species occur in the caves which have not yet been recorded for the region. Several novelties are described.

**Mosses of the Iberian Peninsula.**†—P. Merino publishes a list of twenty-seven of the more interesting acrocarpous mosses collected in the Iberian peninsula, and preserved in his herbarium. The determinations have been revised by J. Glowacki, an Austrian bryologist. Several of these species are new records for both Spain and Portugal, and some for one or other of these countries. Some notes descriptive of structure are given.

**Mosses of Borneo.**‡—H. N. Dixon gives an account of a collection of mosses gathered in Borneo by C. H. Binstead. A striking feature is the peculiar ecological distribution of the genera *Syrrhopodon* and *Calymperes*; some twenty or more species of each occur in Borneo. They are coastal, without being maritime; nor are they hygrophytic. Some 130 species are enumerated; and several critical notes on their structure are included. The number of new species described and figured is fourteen, besides new varieties and forms.

**Peruvian Mosses.**§—R. S. Williams gives a list of seventy-one Peruvian mosses collected by members of the Yale Expeditions of 1911 and 1915. The following six species are new to science, and details of their structure are described and figured:—*Leptodontium integrifolium*, *Globulina peruviana*, *Tortula lacerifolia*, *Grimmia rivulariopsis*, *Bryum biforme*, *Hygrohypnum peruviense*.

## Thallophyta.

### Algæ.

(By Mrs. E. S. Gepp.)

**Anomalous Forms of Ceratium hirundinella.**‖—G. Huber-Pestalozzi has studied the anomalous forms of *Ceratium hirundinella*. His results

* Bull. Acad. Sci. Cracovie, Ser. B, 1915, pp. 121–79. See also Bot. Centralbl., cxxxii. (1916) pp. 221–2.

† Bol. R. Soc. Española Hist. Nat., xvi. (Madrid, 1916) pp. 270–6.

‡ Journ. Linn. Soc., xliii. (1916) pp. 291–323 (2 pls.).

§ Bull. Torrey Bot. Club, xliii. (1916) pp. 323–34 (4 pls.).

‖ Verh. Schweiz. Naturf. Gesellsch. 1914, pp. 191–3.

are as follows :—A number of remarkable anomalies occur, which represent the end of a series of variations, the intermediate forms being perhaps missing. The anomalies in external form occur principally in the appendages (horns) of the cellulose-covered *Ceratium* cell. Abnormalities have been observed on all the three or four horns. The posterior horns appear to be most often affected. The various abnormal variations occurring in each of the four horns are described. Combinations of malformations have also been observed. The numerous forms of anomalous growth may be grouped as follows :—1. Extreme difference of length of single horns. 2. Extreme difference of direction of the same. 3. Abnormal distribution of substance on certain regions of the body. 4. Aplasia and hypoplasia. 5. Hyperplasia (outgrowths, forking, duplication). The first three of these groups are somewhat atypical, the last two more typical. As regards the etiological side of these form-anomalies, nothing has been definitely established. It is probable that the callus-like thickenings of the cellulose shield at the horns has a traumatic origin. Many malformations are probably connected with the process of division (regeneration, super-regeneration).

**Carteria Fritschii.***—H. Takeda gives an account and figures of *Carteria Fritschii*, a new species of flagellate fresh-water alga found at Keston (Kent) in May, 1915, and cultivated for six months. It is remarkable for the thickness of its outer cell-membrane, and also for the much-developed gelatinous inner cell-wall, the unevenness of which often prevents the protoplast from conforming with the contour of the cell. It is a small ovoid organism with four radiating flagella, and contains a single chromatophore, a conspicuous pyrenoid, a stigma, two contractile vacuoles, and a nucleus. It has a forward or a slower backward movement at will ; and it shows an affinity with *C. multifilis* (Fres.) Dill. It is reproduced by longitudinal division of the mother-cell in one or in two directions.

**Chlamydomonas sphagnicola.**†—F. E. Fritsch and H. Takeda have further investigated the green flagellate alga previously described as *Isococcus sphagnicolus*, and have come to the conclusion that it does not constitute a distinct genus, but is a somewhat peculiar species of *Chlamydomonas*. It was found first at Keston (Kent) and subsequently in Richmond Park. It is rather large, more or less ellipsoid, with a very thick cell-wall (the outer layer firm, the inner layer gelatinous and four times as thick), having at the anterior pole two papillæ, or a single papilla which is usually bilobed—one of the most striking features of the plant. The flagella are about one quarter longer than the cell. The chromatophore is single ; the pyrenoids four or more, and conspicuous ; the stigma conspicuous ; nucleus central ; contractile vacuoles two ; propagation by longitudinal division of the mother-cell into two, four or eight parts.

* Ann. Bot., xxx. (1916) pp. 369 72 (figs.).
† Ann. Bot., xxx. (1916) pp. 373-7 (figs.).

**Zoospore Formation in Characium.*** — G. M. Smith gives an account of zoospore formation in *Characium Sieboldii* A. Br., one of the Protococcales. Mature cells of this plant contain 32–64 nuclei, and one or more irregularly shaped pyrenoids. The process of zoospore formation is one of progressive cleavage, the first cleavage planes being transverse and the later ones longitudinal. The cleavage continues until angular uninucleate protoplasts are formed. The pyrenoid does not divide, but disappears during the process. The angular protoplasts become zoospores by rounding up, forming pyrenoids and cilia. After coming to rest the zoospore develops without cell-division into the new plant, but the nuclei increase in number by simultaneous division as the cell enlarges.

**Cytology of Pediastrum.†** — G. M. Smith describes the cell structure and zoospore formation in *Pediastrum Boryanum* (Turp.) Menegh., one of the Hydrodictyaceæ. The youngest cells of this plant are uninucleate, and each contain one pyrenoid (rarely two or three). Mature cells contain four or eight nuclei and one to three pyrenoids. The nuclei increase in number by simultaneous division so that the number is always a multiple of two. In structure the resting nucleus differs but little from the nucleus of the higher plants. The pyrenoids are homogeneous in structure and surrounded by curved starch plates. Previous to zoospore formation there is a period of active simultaneous nuclear division resulting in 16, 32, 64, or 128 nuclei within the cell. The zoospores are formed by cleavage. The cleavage is progressive, forming first multinucleate protoplasts and later uninucleate ones. The pyrenoid disappears previous to or during the first stages of cleavage. After cleavage is completed the nuclei become dense, and the line of demarcation between the protoplasts disappears, reappearing shortly before the zoospores are liberated.

**Organization of the Colony in Certain Four-celled Algæ.‡** — G. M. Smith discusses this subject and describes his experiments. His results are summarized as follows:—The arrangement of the cells in cœnobic algæ may be classified according to the relationships of the cell axes (isoaxial and heteroaxial). Pure cultures or unialgal cultures should be used for studying the variations occurring in any given species. The marked variation described by Grintzesco for *Scenedesmus acutus* was not found in the author's pure cultures. Changes in the environment produce changes in the individual cells of the cœnobe (*Biaiometamorphosis*), but have small effect upon the special inter-relationships of the cells. The variations in cleavage of the mother-cell are little affected by external conditions. When the autospores are motile they are influenced by external conditions through the influence on the motility of the zoospores. The variations occurring in the

* Ann. Bot., xxx. (1916) pp. 459–66 (1 pl. and figs.).
† Ann. Bot., xxx. (1916) pp. 467–79 (1 pl. and figs.).
‡ Trans. Wisconsin Acad. Sci. Arts and Letters, xvii. (1914) pp. 1165–1220 (7 pls. and 7 figs. in text). See also Bot. Centralbl., cxxxii. (1916) pp. 173–5.

cultures of the algæ studied are not sufficient to warrant any assumption of widespread polymorphism among the algæ.

**Protection of Fresh-water Algæ against Animals.***—H. Michaelis publishes the result of his investigations into the methods adopted by fresh-water algæ to protect themselves from being eaten by animals. The result is achieved sometimes by chemical substances, or by external development, or by a covering of slime or jelly. The efficacy of chemical means was proved by removing the protective substance from an alga and offering it to water-animals together with fresh material. They chose the former. Experiments with various chemical substances are described. *Chromulina Rosanoffii* is protected by the fact that its resting cells on the surface of the water are out of the reach of microscopical and semi-microscopical crustaceans; and *Chromulina* is therefore able to multiply and make good the damage done by devouring animals. The author has also investigated the effect of incrustration on algæ. In some cases incrusted algæ escape being eaten, but on the other hand diatoms and desmids form a food supply for certain animals. What may be the defensive factor in certain incrusted algæ is not known. Bristles and external excrescences are efficacious as a rule, but not entirely so. Instances are given of even *Ceratium hirundinella* being devoured by animals. The author considers that gelatinous coverings act quite as well as chemical and mechanical methods of protection.

**Fresh-water Algæ.**†—E. L. Platt discusses the population of the "blanket-algæ" of fresh-water pools—in other words, the community of life which is found among floating masses of filamentous algæ. The material came from pools at Ithaca, near Cornell University, U.S.A. The most frequent alga was *Spirogyra varians*, which was largely associated with *Mougeotia* and *Zygnema*. A great variety in seasonal conditions was observed. The population inhabiting the masses of filamentous algæ consisted of diatoms, desmids and other algæ, as well as animals. The dominating diatoms were *Cocconema*, *Navicula*, *Gomphonema*, and *Synedra*. Other algæ were best represented by *Closterium*, *Dictyosphærium*, and *Dinobryon*. The seasonal variation was different in the different pools.

**Nuclear Division in Desmids.**‡—Elizabeth Acton publishes the first of a series of studies on nuclear division in desmids, and gives an account of what occurs in *Hyalotheca dissiliens* (Sm.) Bréb. Desmids, with few exceptions, do not tolerate artificial conditions, and therefore cannot be cultivated with success; and it is a matter of chance that they should be found undergoing division under natural conditions. *Hyalotheca* was obtained in sufficient quantity to yield complete results, but unfortunately its nucleus is too small to show all that is desired. In

* Jahresb. Grossh. Realschule Schönberg (Meckl.). Schönberg: Lehman und Bernhard (1915) 38 pp. See also Bot. Centralbl., cxxxii. (1916) pp. 137–9.
† Amer. Nat., 1915, pp. 754–62. See also Bot. Centralbl., cxxxii. (1916) p. 238.
‡ Ann. Bot., xxx. (1916) pp. 379–82 (1 pl. and figs.).

its nuclear division granules appear on the network and become larger and fewer, while the nucleolus disappears; these stages are obscure, but probably the chromosomes are being formed on the spireme. Then about twelve short broad chromosomes are seen collected on the equatorial plate: fibres, but no definite spindle, can be made out. These stages are all figured, also the metaphase, anaphase, telophase. In the daughter-nuclei the chromosomes disappear, granules appear and gradually fuse to form the large nucleolus. The daughter-nuclei move asunder at once and become situated opposite the pyrenoids. Formation of the new cell-wall was not observed in detail: but it is always completed before the division of the chromatophore begins. As the chromatophore divides the nucleus slips in between the two halves until it finally reaches the pyrenoid and, during the division of the pyrenoid by constriction, remains firmly pressed up against it. Division of the chromatophore and pyrenoid is probably largely influenced by the presence of the nucleus. The starch sheath of the pyrenoid is not markedly affected until chromatophore division begins; the starch sheath then rapidly sinks and disappears. The presence of a large store of starch in the cell is not in itself sufficient to induce nuclear division.

**Pinnularia.***—N. E. Brown describes and figures the plan upon which *Pinnularia* is built, giving first an account of the structure of the silicious skeleton, based chiefly upon observations made upon *P. major*, *P. nobilis* and *P. gentilis*; and, secondly, recording such observations as he has made upon living specimens. He describes the structure in plain language, explaining the meaning of the technical terms. He points out that the costæ are not solid, but "sausage-shaped cavities in the substance of the cell-wall, separated from each other by a thin plate of silex." The presence of these large cavities with the large opening into the interior distinguishes *Pinnularia* from *Navicula*. The walls of these cavities are described, and also a structure which the author believes to be pores, extending along the centre of their outer wall. The conclusion of the paper is to follow.

**Fresh-water Diatoms.**†—V. Torka writes on the diatoms of the great Jesuit Lake near Bromberg. In the mud was found *Mastogloia baltica* Grun., hitherto recorded only from brackish water, and *M. elliptica* var. *Dansei*, which occurs in fossil strata in Mexico. *M. Smithii* is found, but more rarely. *Navicula vulpina* is figured here for the first time, and the characteristic points of its structure are shown. Forty-three of the species here recorded have been found in the interglacial moor strata of Posen; and since most of the others are still found in living form in West Prussia, it is concluded that the "Faulschlamm" of Schilling, near Posen, originated from a lake similar to those still existing.

* Journ. Micrology, No. 15 (1916) pp. 35–40 (figs.).

† Ber. Westpreuss. Bot. Zool. Verein Danzig, xxxvii. (1915) pp. 332–6 (2 figs.). See also Bot. Centralbl., cxxxii. (1916) p. 207.

**Calcareous Nodules.***—O. Penzig describes some ellipsoidal calcareous nodules, 0·5–2·5 cm. in length, from the mountain stream Secca, north-west of Genoa. In the bed of the torrent are found small basins, not exceeding a metre in diameter and 10–30 cm. deep, where the water is limpid and calm; at the bottom of these the nodules are found. They are therefore not formed by the action of the water, but are concretions generated in situ, around fragments of herbaceous plants. Round this centre the lime appears to be slowly deposited. If the nodules are dissolved in acid, however, it is found that surrounding the vegetable fragment constituting the centre there is a mass of gelatinous, delicate, greyish substance, composed of entangled minute filaments, reproducing exactly the form of the nodule. They constitute almost exclusively the organic base of the nodules, and are composed of masses of *Streptothrix hyalina* Migula. The part which this organism takes in the formation of the nodules is difficult to determine, but there would appear to be a genetic connexion between the bacterium and the inorganic mass. Possibly the *Streptothrix* develops on the plant-fragments in the water, and round the mass thus produced are deposited the molecules of calcium carbonate. Thus, while the colony of bacteria grows in size, the nodule keeps pace with it. This may be the result of a purely mechanical action; or it may be that by means of some physiological process the filaments of *Streptothrix* play an active part in the precipitation and deposition of calcium carbonate. In all cases of calcareous nodules hitherto recorded, species of Schizophyceæ have been present, belonging to Oscillariaceæ, Rivulariaceæ and Scytonemaceæ. They have played an active and important part in the formation of other calcareous incrustations. But never has any bacterium been recorded other than free and without calcareous incrustation.

**Chara crinita.**†—A. Ernst has made a study of *Chara crinita*, which since the investigations of A. Braun (1856) and Migula (1888–1890) has been recognized as an example of true parthenogenesis in the vegetable kingdom. The author has made fresh cultural experiments and cytological investigation, and he asserts as the results that in this plant somatic parthenogenesis (ovogenous apogamy), not generative parthenogenesis, occurs. This is contrary to the view held hitherto, but is in accordance with what is found among Angiosperms.

**Alternation of Generations in Florideæ.**‡—N. Svedelius discusses the problem of the alternation of generations in Florideæ. He opens his paper with an historical account of the work done on the subject, beginning with Camerarius at the end of the 17th century. He then proceeds to give an account of the position of the reduction-problem and the alternation of generations in Florideæ, the pioneer work of Nägeli, Bornet, Thuret and Schmitz, etc., being followed by the younger investigators, including the author himself. The results of each writer are described and illustrated by figures. The conclusion of all the work

* Malpighia, xxvii. (1916) pp. 401-5 (1 pl.).
† Act. Soc. Helvét. Sci. Nat., Session 97 (1915) p. 198.
‡ Naturw. Wochenschr., n.f. xv. Nos. 25-6 (1916) 40 pp. (14 figs.).

done is to show that in that complete and well-defined unity, the Florideæ, there exist two quite different types of reduction-division: and this explains the fact that some genera are wholly devoid of tetraspores, which are, as a rule, so characteristic of the group. The non-tetraspore-bearing Florideæ (Nemalionales) have a reduction-division, which immediately follows fertilization. The monospores which occur in these types are pure germ-cells, which are not a necessary link in the course of the alternation of generations. These two types of reduction-division differ in this way, that in the first type only one kind of individual occurs, namely (monœcious or diœcious) sexual individuals with or without monospores; while in the second type two kinds of individuals occur, namely, partly sexual individuals, monœcious or diœcious, and partly asexual tretraspore individuals; and between these two kinds of individuals there takes place a regular alternation. Since the first type is characterized by the appearance of the plant in only one form, it is here called haplobiontic; the second type, which appears in two forms, is called diplobiontic. It must be noted that these different forms in the diplobionts do not coincide strictly from the cytological standpoint with the two generations, since the diploid gonimoblast and the carpospores belong equally to the diploid sporophyte generation. The form in this sense must therefore not be confused with the generation. As to the problem concerning priority of type the author shows that the haploid gametophyte is primary and the diploid secondary. The probable original development of the diploid from the haploid is described. The diploid tetraspore-forming generation must have been formed at one jump, so to speak, as is shown by the author. The question as to what effect this discovery of the two types of reduction-division will have on the systematic arrangement of the Florideæ is propounded. It cannot be left out of consideration.

**Position of Chromatophores.***—G. Senn writes on the position of the chromatophores in the palisade cells of marine Florideæ. In *Peyssonnelia Squamaria* and *Platoma cyclocolpa* the chromatophores, in a diffused illumination of medium intensity, lie in antistrophe on the portions of the membrane turned to the light. If the under side of the thallus of *Peyssonnelia* is illuminated, the chromatophores are obliged to collect in the anatomically lower cell-ends, which are then the best lighted. By prolonged darkening of the cells of *Platoma*, apostrophe can be caused; intensive illumination, on the other hand, produces parastrophe. The difference between the arrangement of the chromatophores in the palisade cells of marine algæ (antistrophe) and of foliage (epistrophe) under optimal diffuse illumination is due to the difference of optical conditions. If water is injected into the intercellular air spaces (which in leaves bring about the total reflection of the light rays which have penetrated into the palisade cells) so as to make the optical conditions equal to those of the marine algæ, then, under a convergence of light rays of 90° and more, the same arrangement of chromatophores takes place in the palisade cells of the leaves as in those of the Florideæ examined, namely, antistrophe.

* Act. Soc. Helvét. Sci. Nat., Session 97 (1915) p. 203.

**Marine Algæ from North Carolina.***—M. A. Howe and W. D. Hoyt describe the novelties found in a collection of marine algæ from Beaufort, North Carolina, dredged from a submerged reef which forms the northern limit of certain tropical and subtropical algæ. Seven species are new, and two had previously been recorded only from Europe. The novelties are: *Microchæte nana*, *Derbesia turbinata*, *Phæostroma pusillum*, *Erythrocladia recondita*, *E. vagabunda*, *Acrochætium infestans*, *A. affine*. The two new extra-European records are: *Streblonema solitarium* (Sauv.) De Toni, and *Elachistea stellulata* Griff. Figures are given of the new species.

**Gametophyte of Laminaria.**†—C. Sauvageau describes in detail the gametophytes of *Laminaria flexicaulis* and *L. saccharina*. Last year he announced his discovery of a sexual and asexual alternation of generations in *Saccorhiza*, which in its main lines resembled *Equisetum*. He now describes a similar occurrence in the two species of *Laminaria*, though the process of development differs in certain details. The antheridia and oogonia are described fully, and figured. The female prothallus is the "protonema" of Williams and of Kilian.

## Fungi.

(By A. Lorrain Smith, F.L.S.)

**Development of Protomyces.**‡—G. von Büren finds that the resting-spore of *Protomyces* is multinucleate, the nuclei being extremely small; they seem to contain a nucleolus and a nuclear vacuole; chromatin could not be detected.

On germination the endosporium pushed out as a globose swelling or as a cylindrical tube, and the plasma and nuclei pass over into the sporangium so formed; gradually the plasma and nuclei move towards the wall, and then become divided into four separate portions which are uninucleate, and later form the uninucleate spores. No nuclear fusion was observed. In the chlamydospores paired nuclei were found, but the pairs might possibly be the result of division rather than of pairing.

**Conjugate Nuclei in the Ascomycetes.**§—E. J. Welsford draws attention to the constant appearance of conjugate nuclei in the mycelium of *Botrytis*, and she explains the phenomenon as due to rapid nuclear divisions, the resultant daughter-nuclei remaining for some time in pairs. Similar observations were made on the nuclei in well-nourished hyphæ of *Sclerotinia Libertiana*. From this she argues that conjugate nuclei in ascogenous hyphæ are not necessarily indicative of sexual origin.

* Memoirs New York Bot. Garden, vi. (1916) pp. 105–23 (5 pls.).
† C.R. Acad. Sci. Paris, clxii. (1916) pp. 601–4 (figs.).
‡ Verh. Schweiz. Nat. Ges., 1914, pp. 193–5.
§ Ann. Bot., xxx. (1916) pp. 415–7 (4 figs.).

**Cultures of Mycosphærella Fragariæ.***—H. C. Schellenberg has confirmed previous results as to the different stages in the life of this fungus; he took mature ascospores from the leaves of the strawberry and sowed them on gelatine fruit-decoction. As a result he obtained *Ramularia* conidia. He found the same *Ramularia* (*R. Tulasnei*), as the summer fruit forms of the fungus, on the leaves of the plant. Infection of new leaves takes place through the stomata. He found also a pycnidial form, *Ascochyta Fragariæ*, which developed during the winter. All diseased leaves should be collected and burned in early spring.

**Rœsleria pallida Sacc.**†—A careful study of this fungus has been made by J. Bayliss-Elliott and W. B. Grove. They have also examined and compared the specimens of *Pilacre Petersii* and *P. faginea*. In the latter they failed to find any evidence of the basidiosporous state, though clamp connexions were observed; they considered them to be conidiophorous fungi without any connexion with Auriculareæ or Tremellineæ, and they decide that *Pilacre* is probably a conidial stage of species of *Rœsleria*.

**Study of Citromyces.**‡—This genus was created by Vehmer in 1893, to contain certain Hyphomycetes that were able to induce the formation of citric acid in culture media. One of Vehmer's species, *Citromyces Pfefferianus*, has been studied by Gino Pollacci along with other species of the genus, and on morphological grounds he considers all of them to be species of *Penicillium*, and most of them probably synonyms of *Penicillium* species already known.

**Coniothyrium pirinum Sheldon.**§—Elisa Mutto and Gino Pollacci have made cultural studies of the above fungus, and have concluded that it is identical with *Coniothyrium tirolense* Bubak, which also occurs on leaves of *Pirus communis*. They have also decided that *Phyllosticta prina* is not synonymous with the above two species, the spores being persistently hyaline in all cultures, while the spores of *Coniothyrium*, though hyaline at first, become brown in time.

**New Species of Endothia.**‖—Stephen C. Bruner found the new fungus on the bark of various species of *Eucalyptus*, generally on that of dead or injured trees. It was cultivated on artificial media (rice and potato agar) and grew well, producing characteristic pycnidia with yellow or orange-yellow spore tendrils.

**Uredineæ.**—E. B. Mains ¶ cites *Coleosporium Solidaginis* as one of the heterœcious rusts that persists in districts where the alternate æcidial form is not found. By careful examination he found that the

* Act. Soc. Hélv. Sci. Nat., 1915, p. 212.
† Ann. Bot. xxx. (1916) pp. 407–14 (10 figs.).
‡ Atti Ist. Bot. Pavia, xvi. (1916) pp. 121–36 (1 pl.).
§ Atti Ist. Bot. Pavia, xvi. (1916) pp. 209–12.
‖ Mycologia, viii. (1916) pp. 239–42 (1 pl.).
¶ Phytopathology, vi. (1916) pp. 371–2.

fungus wintered in the rosette leaves of the plant; mycelium was found in these leaves though only in limited areas, and uredospores produced from the mycelium in spring serve as the source of renewed infection.

J. E. Weir and E. E. Hubert* record successful inoculations of *Larix occidentalis* and *L. europæa* with *Melampsora Bigelowii*. The teleutospores were applied in April, and spermogonia and æcidia appeared in the following May. *Abies lasiocarpa* was successfully infected with *Pucciniastrum pustulatum*, collected from the leaves of *Epilobium angustifolium*.

**Dry-rot.**†—Percy Groom gives an account of *Merulius lacrymans*, which causes dry-rot of timber. After attacking the wood, it sends down into the tissues fine hyphæ which feed on the wood-substance, and it also gives forth superficial hyphæ which form into strands, sheets, or cushion-like growths, which send down further hyphæ into the wood. Spore-bearing tissues are superficial, but in the immersed mycelium "gemmæ" and oidia may also be formed. Methods of dealing with the fungus are described.

**Cultures of Rhizoctonia crocorum.**‡—As the disease associated with the fungus is increasing in America, W. H. Diehl has devoted some time to a study of the fungus in artificial cultures. He found that the fungus was of very slow growth. The best results were obtained on "radicicola" agar, which contains water, saccharose, dipotassium phosphate and agar-agar in definite quantities, but, even on this medium, very poor growths were obtained, and these were not found to be capable of infecting healthy alfalfa roots.

**Horse-hair Blights.**§—T. Petch gives a description of these hair-like structures, fine rhizomorphic strands of mycelia which spread freely over bushes and trees at some height from the ground. So far as is known, all these black threads belong to some species of *Marasmius*; the common species in the Eastern tropics being *Marasmius equicrinis*, and in the West Indies *M. sarmentosus*. The mycelium is purely epiphytic, and adheres to the leaves and branches of the trees by thin disks of fine brown hyphæ. These anchoring hyphæ may rise from any part of the rhizomorph, but their formation seems to depend on the supply of moisture.

Petch has described several other Ceylon species of *Marasmius*, and a new *Xylaria*, *X. vagans*, which grows on leaves.

**Pseudo-sclerotia of Lentinus similis, etc.**‖—An account of the development of these sclerotia is given by T. Petch. The mycelium of the fungus permeates the wood on which it grows, filling all the elements of the wood or the spaces, and forms with the wood a solid

* Phytopathology, vi. (1916) pp. 372–3.
† Journ. Board Agric., xxiii. (1916) pp. 465–74 (12 figs.).
‡ Phytopathology, vi. (1916) pp. 336–40.
§ Ann. Roy. Bot. Gard. Peradeniya, vi. (1915) pp. 1–26 (6 pls.).
‖ Ann. Roy. Bot. Gard. Peradeniya, vi. (1915) 18 pp. (1 pl.).

mass. On one such mass, twenty-three pilei of *Lentinus* were found. They differed in the stages of development, but they arose chiefly from the bark that still adhered to the sclerotium on which they were situated at the junction of the bark and the wood.

Petch discusses the question of sclerotia in *Lentinus*, etc.

**Descriptions and Illustrations of American Fungi.**—W. A. Murrill* has issued coloured figures of five Amanitas that occur in America, with scientific descriptions and notes. Murrill gives not only his own new names for these plants, but the names by which they are known throughout the world. A special note of warning is given concerning the poisonous *Amanita phalloides*.

F. J. Seaver † has published a photographic plate and a description of *Peziza clypeata*. The species was originally described by Schweinitz from N. Carolina. It varies in size from 3 to 4 cm., and in colour from reddish-brown to greenish-black. The plant has been named and renamed many times. It grows on damp logs.

**New Species of Micromycetes.**—Elisa Mutto ‡ has determined a number of new parasitic fungi on exotic plants grown in the botanical garden at Pavia. These are *Phomopsis Diploglottidis*, on leaves of *Diploglottis*; another, *Phomopsis Briosii*, on leaves of *Roupala nitida*: a *Coniothyrium*, on the cladodes of *Ruscus Hypoglossum*; and *Centhospora Pollaccii*, on a dead stem of *Chamædorea elegans*.

In the fourth contribution to the "Micologia Lignstica," Luigi Maffei § publishes descriptions and figures of four new species of micro-fungi on the leaves of various plants: *Phomopsis Cocculi*, *Macrophoma Cinnamomi-glanduliferi*, *Macrophoma Yuccæ* and *Pleospora Briosiana*, the latter a parasite of *Bignonia buccinatoria*.

**Mycological Notes.**‖—C. G. Lloyd publishes notes on a series of rare fungi that have been sent to him for identification. They include *Cordyceps sobolifera* from Japan, which develops on the *Cicadidæ*, and was first recorded from the West Indies; a rare species of *Sebacina*, with cruciate basidia; *Cytarria Gunni*, a fungus of the southern hemisphere used as food by the natives of Terra del Fuego; and *Hypoxylon cerebrinum*, a very large species from Trinidad, originally named by Fée, from Brazil specimens. A number of other unusual basidiomycetes are also included in the notes.

**Studies of the Physiology of Parasitism.** — II. *Infection by Botrytis cinerea.*—V. H. Blackman and E. J. Welsford ¶ here record the results of culture experiments in the parasitism of *Vicia Faba* by *Botrytis cinerea*. The spores were grown in drops of turnip juice on the leaf of the bean. After germination the spore tube becomes

* Mycologia, viii. (1916) pp. 231-4 (1 pl.).
† Mycologia, viii. (1915) pp. 235-8 (1 pl.).
‡ Atti Ist. Bot. Pavia, xvi. (1916) pp. 205-7 (1 pl.).
§ Atti Ist. Bot. Pavia, xvi. (1916) pp. 225-43 (1 pl.).
‖ Cincinnati, Ohio, 1916, pp. 574-88 (pls. and figs.).
¶ Ann. Bot., xxx. (1916) pp. 389-98 (1 pl. and 2 figs.).

invested with a mucilaginous covering which anchors it to the substratum; it exercises considerable pressure on the underlying tissue, and penetrates by a fine peg-like outgrowth from the part of the tube that is pressed against the leaf surface. The piercing of the cuticle was shown to be due solely to the mechanical pressure exerted by the fungus. After penetration enzyme action occurs, causing the swelling of the subcuticular layers. Death of the epidermal cells in advance of the penetration does not occur; there is no microscopic evidence of the secretion of a toxic substance other than the cell-wall dissolving enzyme.

III. *On the relation between the Infection Drop and the underlying Host Tissue.*—W. H. Brown * found in the course of his experiments on the same fungus that the germ tubes were unable chemically to affect the cuticle of the host, nor do they secrete any toxic substance which can pass through the cuticle and bring about the death of the underlying cells. The fungus is unable to affect the underlying tissue until the obstacle afforded by the cuticle has been overcome. Chemical action being excluded, penetration of the cuticle must take place in a purely mechanical way, as was demonstrated by Blackman and Welsford.

Another paper by W. Brown † on the same subject gives a résumé of the subject, with special reference to the behaviour of *Botrytis cinerea*. An extract of the fungus was made and injected into the living plant, with the result that the cell-walls were disorganized and the cells killed. In half-an-hour after treatment the cells of a potato fell apart owing to the process of disorganization—the death of the cell is shown by the brown or black coloration of the contents. The action exactly resembled that of the parasite. Brown also found that the extract had no effect when applied to the surface of the plant; it is unable to penetrate the outer cuticle. Notes are also given as to the behaviour of the extract to reagents—acids, alkalies, salts, etc.

**Potato-wilt and Tuber-rot caused by Fusarium eumartii.‡**—R. J. Haskell states that in only two cases of *Fusarium* attack—*F. oxysporum* and *F. trichothecioides*—is the wilting of the foliage due to the fungus *Fusarium*. He has proved that *F. eumartii* also gives rise to both symptoms of disease. The culture experiments were made originally from *Fusarium* spores produced on rotting potato tubers. The stems inoculated became diseased, and the leaves wilted. The stems below ground were also attacked, and the tubers. From these latter the fungus was again isolated, and proved to be identical with the original strain.

**Spore Variation in Neopeckia Coulteri.§**—J. S. Boyce calls attention to the occurrence of variations in the number of septa in this fungus, a parasite of several species of Pines in America. Normally the spores are uniseptate and dark brown, while those of *Herpotrichia* are three-

* Ann. Bot., xxx. (1916) pp. 399-406.
† Journ. Board Agric., xxiii. (1916) pp. 474-8.
‡ Phytopathology, vi. (1916) pp. 321-7 (3 figs.).
§ Phytopathology, vi. (1916) pp. 357-9.

septate, so that the occurrence of the variation suggests a very close relationship between the genera. The variously septate spores do not vary much in size.

**Diseases of Greenhouse Tomatoes.*** — M. T. Cooke and C. A. Schwarze have described two diseases—one on the leaves, the other on the fruits of the tomato plant—in New Jersey. The former is due to one of the Sphæropsideæ, *Ascochyta Lycopersici*. It grows on somewhat circular spots on the leaves, and very generally forms pycnidia and spores. It has been recorded on weak tomato plants in Italy and France, but in New Jersey it grew on both old and new leaves of vigorous plants. The fruit-rot was found to be due to a species of *Botrytis*.

**Disease of Red Cedar.**†—James R. Weir describes a serious disease of this tree due to *Keithia thujina*, which attacks the leaves. The apothecia of the fungus are embedded in the scale-like leaves of the host, and become exposed by the rupture of the epidermis. At first they are a rich olive-brown, but become almost black with exposure. The spores are peculiar; they are almost globose when mature, are deeply pitted, and have a minute cell cut off at the distal end.

Seedlings are peculiarly liable to attack, but the foliage of the upper crown of large forest trees may become diseased, though not to the same extent as the branches near the ground. Treatment with soap-Bordeaux solution was found effective in dealing with the disease.

**Inky Disease of Chestnut-trees.**‡ — Giovanni Briosi and Rodolfo Farneti have reviewed the various publications on this disease, and they insist that it is due to a *Coryneum*, and not to *Endothia radicalis*. The latter fungus, which is generally considered to be the cause of the trouble, is, according to the authors, a saprophyte that occurs on a number of different trees. They give an account of their own inoculation experiments which led them to this conclusion.

**Disease of Bamboos.**§—Malusio Turconi has investigated a disease that attacked a number of bamboo plants in the botanical garden at Pavia. The damaged branches were partly or entirely dry, whitened, and covered with minute black points. He found that these were due to the acervula of a *Melanconium* new to science, which he has called *M. Bambusæ*. Later in the year stromata were formed, and ascigerous perithecia belonging to the genus *Scirrhia*, named by Turconi *S. Bambusæ*. Proof of the parasitic nature of the fungi was successfully adduced by infection experiments on young branches.

**Verticillium Disease of the Potato.**‖—This disease, described by G. Pethybridge, is due to the hyphomycetous fungus *Verticillium*

* Phytopathology, vi. (1916) pp. 364-6 (1 fig.).
† Phytopathology, vi (1916) pp. 360-3 (2 figs.).
‡ Atti Ist. Bot. Pavia, xvi. (1916) pp. 213-24.
§ Atti Ist. Bot. Pavia, xvi. (1916) pp. 245-52 (1 pl.).
‖ Sci. Proc. Roy. Dublin Soc., xv. (1916) pp. 63-92 (2 pls.).

*alboatrum*. In artificial cultures it produces first of all white mycelium and conidiophores, but in time a black submerged mycelium is formed. The black mycelium is also produced in potato stalks, and causes the blackening of the tissues. The first visible symptoms of disease are the gradual desiccation and death of the plants; the fungus which inhabits the wood vessels passes down into the tubers, and if these are planted the disease spreads again to the new growths, though it has also been proved that diseased tubers may produce healthy plants.

The disease is not as yet common in the British Isles; but if it became prevalent the consequences might be very serious. The most satisfactory preventive measures are to maintain a proper rotation of crops, and to take steps to ensure that the potatoes used for seed purposes are healthy.

**Smut Disease of Bamboos.***—Flora W. Patterson and Vera K. Charles give an account of this disease, *Ustilago Shiraiana* Hennings. It was found on timber bamboos that were being transported from California to other suitable districts in the United States for economic planting. The disease is of extreme virulence, and may quickly destroy a whole forest of bamboos. It is prevalent and destructive in Japan, from which country the species of bamboo in question, *Phyllostachys henonis*, had been imported into California. The fungus always occurs on the young and growing points of branches, causing them to swell somewhat under the leaf-sheaths, though there is no external discoloration. The growth of the branches is arrested, and as the external coverings fall away the sooty fungus is laid bare. Burning of all diseased plants is the only sure means of eradicating the fungus.

## Schizophyta.

### Schizomycetes.

**Studies on Shiga's Bacillus.**†—M. Nicholle, E. Debains, and G. Loiseau have studied *Bacillus dysenteriæ* Shiga in relation to its morphology, toxicity, agglutination reactions, and preparation of specific anti-toxin. The organism is non-motile, Gram-negative, and the cultures exude an odour of chestnuts. Colonies upon agar and on broth resemble those of typhoid, but are more luxuriant. When the medium used is moderately alkaline, a ring is formed at the surface of the medium, which if alkaline to phenol-phthaline induces the development of a scum that re-forms on being detached. A slight yellowish growth is formed on potato, and gelatin is not liquefied. The reactions of the bacillus on the following media are the same as with *B. typhosus*: milk, glucose broth, neutral and glucose agar, and litmus-lactose agar. It strongly reddens litmus-glucose agar, but does not ferment mannite,

* Phytopathology, vi. (1916) pp. 351–6 (1 fig.).
† Ann. Inst. Pasteur, xxx. (1916) pp. 363–82.

maltose, or saccharose. It does not produce indol, and does not blacken lead agar ("gélose au plomb"). It has a tendency towards autolysis. Practically, the bacillus may be considered as avirulent, but it has strong toxin-producing powers. The toxin produces characteristic symptoms and lesions among rabbits (emaciation, paralysis of the fore-quarters, diarrhœa, and coma). The toxin resists the action of heat and acids.

**Etiology of Infectious Anæmia of Horses.***—Cairé and Vallée summarize the results of their protracted investigations into the etiology of equine infectious anæmia as follows:—The malady is infectious, inoculable, and due to an ultra-microscopic filter-passer. The blood and urine of the sick horses are infective. The virus is destroyed by heating to 60° C. The infection is present in the digestive tract and in the urine. Horses to all appearances healthy may in reality be infective, and may spread the disease to other animals.

The illness is transmitted by the digestive passages. In the course of its evolution the anæmia presents violent paroxysms, characterized by fever, hæmatogenous jaundice, and hæmaglobinurea. The blood has a low hæmaglobin index, and is of low coagulability. The red cells agglutinate, and the serum is strongly stained and dichröic. In the intervals between the crises, the disease is manifested by albuminuria and by the condition of the heart. Post-mortem splenomegaby, a large "cardiac" liver, endocarditis, and changes in the marrow of the long bone are manifested. Separation, surveillance of sick animals, disinfection of dejecta, and protection of drinking-water, are strongly indicated in prophylaxis. The destruction of the bodies of the sick animals is also indicated. Up to the present, vaccination and serum-therapy have been barren of results.

**Destruction of Schistocerca peregrina in Morocco.**†—H. Velu and A. Bouin have carried out a series of painstaking investigations in Morocco with d'Hérelle's *Coccobacillus acridiorum*, and find that the exaltation of the bacillus to the point of killing the insect in three or four hours by means of intra-abdominal inoculation is comparatively easy. The virulence of the organisms, however, varies with the temperature, the age of the locusts inoculated, and the age of the cultures. A virus, for instance, which kills in three to four hours at 25°–30° C. takes eight to ten hours to kill at 15°–20° C.; and a virus which kills a locust fifteen to twenty days old in four hours may take as long as fourteen hours to cause the death of a thirty to forty days' old insect.

The methods of d'Hérelle gives encouraging results, but it is difficult to appraise their exact value. The virulence of the cultures is very fugative, and as the epidemic spends itself the proportion of the morbidity to the mortality gradually increases. The evolution of the epizootic is conditioned by the number of diseased locusts which fall victims to their healthy comrades, and the infection may be artificially

* Ann. Inst. Pasteur, xxx. (1916) pp. 383–8.
† Ann. Inst. Pasteur, xxx. (1916) pp. 389–421.

propagated by implantations of sick animals among healthy populations. The employment of d'Hérelle's technique should be used in conjunction with other methods of locust destruction.

**Life-cycles of the Bacteria.*** — E. Löhnis and N. R. Smith contribute, as a "Preliminary Communication," an important memoir on this subject, chiefly based on the study of the life-history of *Bacillus azotobacter*, in which they show that the life-cycles of the bacteria are no less complicated than those of many other micro-organisms. A satisfactory account of the development of one form of this species from another would be too lengthy, and would require the reproduction of a complicated page diagram, but it may be stated that all bacteria studied have been found to live alternately in an organized and in an amorphous stage, from which stage in all cases "regenerative units" develop, and, increasing in size, turn into "regenerative bodies," which later become cells of normal shape. Direct union of two or more individual cells has also been observed. All bacteria are found to multiply not only by fission, but also by the formation of "gonidia," which usually first become regenerative bodies, but sometimes directly grow to full-sized cells. The gonidia are liberated either by complete or partial dissolution of the cell-wall, or they develop while still united with their mother-cell.

The authors state that the discovery of the full life-cycles of the bacteria may be useful in many ways; for the wide morphological variations are connected with great variations in the physiological qualities of the organisms; many so-called species will have to be cancelled, because they merely represent fragments of the life-cycles of other bacteria; systematic bacteriology can now be established on a firm experimental basis; and medical bacteriology as well as agricultural will derive much benefit.

The seven plates are collotype reproductions of forty-two microphotographs of various species of bacteria in different stages and of their gonidia.

**Bacteria in Bottled Waters.†**—Maud Mason Obst gives the results of a bacteriological examination of commercial bottled waters, from which the conclusion is drawn that insufficient care is often exercised in the selection of the spring from which the water is obtained, and afterwards in handling the water. It was found that naturally carbonated waters occasionally contain large numbers of organisms, but that artificially carbonated waters generally contain very few, *Bacillus coli* being almost entirely absent. The results of an examination of two imported waters, bearing on the labels of the bottles "bacteriologically pure," are of interest. Out of six bottles in one sample, four contained *B. coli* in varying and sometimes possibly harmful quantities; and out of seven in the other sample, six did so, besides which thirteen other species were detected, and long-chain streptococci, also moulds of the genera *Trichoderma*, *Penicillium*, *Citromyces*, *Fusarium*, *Actinomyces*, and *Sporotrichum*. One imported water examined contained a large number of spores of a

* Journ. Agric. Research, Washington, vi. pp. 675–702 (pls. A–G).
† U.S. Dept. of Agriculture, Bull. No. 369 (1916) 14 pp.

species of *Actinomyces*, culturally resembling the pathogenetic form, and in another *Sporotrichum* was found in large numbers. The other genera listed, being generally found in soil and in decaying vegetable matter, are not indicative of cleanliness.

**Anaerobic Pyogenic Bacteria.***—F. Putsu claims to have isolated from a case of compound fracture of the femur with gas gangrene, a pure culture of a definitely anaerobic bacterium having special characteristics, and named by him *Bacillus putrificus* var. *non-liquefaciens*.† This bacillus is evidently a micro-organism from the soil, definitely anaerobic, capable of producing putrid decomposition with development of gas and formation of pus in tissues previously injured; in fact, it is one of the germs which are the cause of gas gangrene and gas phlegmon. In cultures all the organisms showed the presence of a spore, were ovoid or club-shaped, with the spore at one extremity. They were motile, with a rectilinear movement which ceased at the edge of the hanging drop where they were in contact with the air. With Ziehl's stain the spore was unstained or nearly so, the body of the organism taking a deep red. With Gram's method, using eosin as a differential stain, young forms of recent growth in broth took a red-violet hue. The red part constituted the body of the bacillus, while the violet represented the edge or membrane of the spore. Elongated non-spore-bearing forms sometimes met with in recent cultures were Gram-negative. Aerobic cultures in broth, broth-glucose, or agar, remained completely sterile. The organism described by Putsu to some extent resembled the *B. lacto-propylbutyricus non-liquefaciens* of Tissier, but differing from it in the following particulars: in not having a central spore, in the absence of spore in elongated forms, in forming irregular broken colonies, and in coagulating milk without the aid of glucose.

**Aspergillosis in the Ostrich Chick.**‡—J. Walker states that chick fever, or yellow liver, sometimes causes a mortality as high as 70 p.c. among ostrich chicks reared on certain farms in South Africa. Various moulds, notably of the *Aspergillus* type, were observed by him in the lesions of chick fever, and were found to be capable of transmitting the disease. *A. fumigatus* appears in the ostrich, and more particularly in the ostrich chick from a few days to about four to five weeks after hatching, the infection occurring in the air-chamber of the egg. Infected eggs are the chief source of infection of incubators, the liberation of *A. fumigatus* from the air-chamber taking place either at the time of hatching or when infected eggs are opened in the incubators. The disease can be transmitted from infected to clean eggs through the unbroken shell.

**Destruction of Acridians by means of Bacterial Cultures.**§—Monod and Velu have applied d'Hérelle's coccobacillus with the view to

* Lancet, September 16, 1916.
† Il Policlinico, Surgical Section, August 15, 1916.
‡ Union of South Africa Dept. of Agriculture Reports, 1915, pp. 533–74.
§ Rec. de Méd. Vét., xcii. (1916) pp. 346–8.

the extermination of locusts in Morocco. D'Hérelle's method provokes very contagious outbreaks among insects, either by the dissemination of broth cultures or by contamination with aid of infected crickets. The contagious enteritis provoked by the coccobacillus among the crickets behaves in the same manner as other epizootic diseases. After a period of incubation one observes a period in which a variable mortality occurs; then a period of decline sets in, with the diminution of morbidity, caused either by attenuation or by increase of resistance of individuals. In the most favourable cases one notices a mortality of 70 to 80 p.c. In other cases the mortality does not exceed 20 to 25 p.c. D'Hérelle's method is very difficult of application, and good results can only be obtained by competent technicians. Moreover, unfavourable atmospheric conditions, such as rain, heavy dews, or bright sunlight, considerably hamper the efficiency of the method. It would also be difficult to spread pure cultures over a large tract of country. The results, however, have been very encouraging, and the authors are prepared to adopt the method on a larger scale.

**Bacteriology of Fæces in Diarrhœa of Infants.***—Captain W. R. Logan has investigated fourteen cases of infantile diarrhœa in which the patients had been fed on artificial food at the time of onset. The flora of artificially fed infants differs from that of breast-fed infants chiefly in a decrease of the acid-tolerant group, an increase of the normal *Bacillus coli* group, and in the appearance of members of the non-lactose-fermenting group along with some increase in cocci. The flora of infants suffering from diarrhœa shows similar but more marked changes, and the more severe the diarrhœa the more marked the changes. It is probable that the acid-tolerant group exerts a beneficial influence in restraining the growth of the non-lactose-fermenting group in the intestines. Bacilli of the non-lactose-fermenting group were obtained from six out of twenty-one (28·5 p.c.) infants and young children who were free from diarrhœa. Bacilli of this group were isolated from eleven out of fourteen cases of diarrhœa (78·5 p.c.). Bacilli of Morgan's No. 1 group were isolated from 9 p.c. of the normal children, and from 35 p.c. of the cases of diarrhœa. True, though non-agglutinable, dysentery bacilli were isolated from none of the normal children, but were obtained from three cases of diarrhœa with blood and mucus (dysentery), or 21 p.c. of total diarrhœa cases. A certain number of cases of diarrhœa of infants are therefore true bacillary dysenteries, even in Scotland and in winter-time. It is doubtful whether the overgrowth of non-lactose-fermenting bacilli initiates the diarrhœa, or whether it is a secondary and aggravating factor.

**Etiology of Cerebro-spinal Fever.†**—E. C. Hort and A. H. Caulfield have followed up the investigations of the former with regard to the association of a filter-passing virus with cases of meningococcal infection.

* Lancet, cxci. (1916) pp. 824–7.
† Lancet, cxci. (1916) pp. 522–4.

They have demonstrated from experiments on monkeys that both filtered and unfiltered cerebro-spinal fluid containing the meningococcus produce the same pathological effects (continued fever or death). In no case did injection of the inocula produce the cardinal symptoms of the disease as it occurs in man, namely, demonstrable involvement of the cerebro-spinal system. The filter-passing agent can, however, be recovered from the tissues of the infected monkey, and can be transmitted to other experimental animals. The pathogenicity of cultures of the meningococcus appears to be due to the concomitant presence of the filter-passing virus described.

# MICROSCOPY.

## A. Instruments, Accessories, etc.*

### (1) Stands.

**New Spencer Microscope, No. 5.**†—The body-tube of this instrument (fig. 34) is of aluminium, and is arranged to accommodate the large low-power photo-micro-objectives as well as those with the Society screw; the oculars are compensating, with lenses of large field. The large arm is conveniently shaped for handling, and has the Spencer side fine-adjustment. There is a free distance of 100 mm. from optical axis to arm. One complete revolution of the thread represents an up-and-down movement of 0·1 mm., and the graduations on the button to 100 parts make the value of each division one micron. The revolving stage is 150 mm. in diameter, the vulcanite area being of 130 mm. in diameter. The nickelled periphery is graduated to degrees, and the vernier reads to three minutes. The mechanical stage is easily removable by simply slipping it off from its bearings, which are embedded in the stage. The bearings may then be covered by a slide provided which makes a clear, even, plane stage without the necessity and expense of buying an extra plane stage. The buttons operating the mechanical stage are on concentric axes, one above the other. There is a range of 80 mm. in lateral movement and 50 mm. in to-and-fro movement. When the large stage is centred by means of the centring screws the two vernier readings of the mechanical stage are all that are necessary to locate an object. The complete rack-and-pinion sub-stage is equipped with an achromatic condenser fitted on the drop-swing mounting.

**Spencer Microscope, No. 10.**‡—This instrument (fig. 35) very closely resembles the No. 5 of the same firm. The chief differences are: (1) in the shape of the arm, with its handle opening; (2) in the lateral movement of the stage, 75 mm. as compared with 80 mm.; (3) in the free distance between the arm and optical axis, 80 mm. as against 100 mm.

* This subdivision contains (1) Stands: (2) Eye-pieces and Objectives; (3) Illuminating and other Apparatus; (4) Photomicrography; (5) Microscopical Optics and Manipulation; (6) Miscellaneous.

† Catalogue, Spencer Lens Company, p. 15.

‡ Catalogue, Spencer Lens Company, p. 15.

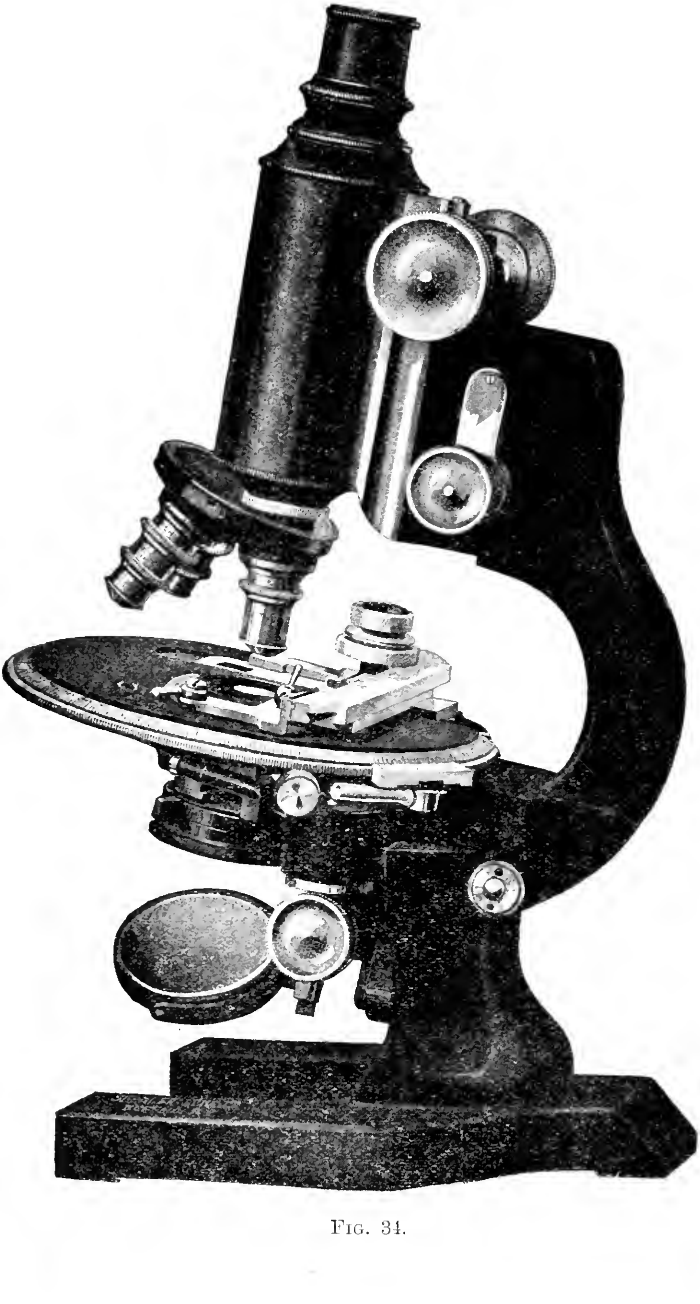


Fig. 34.

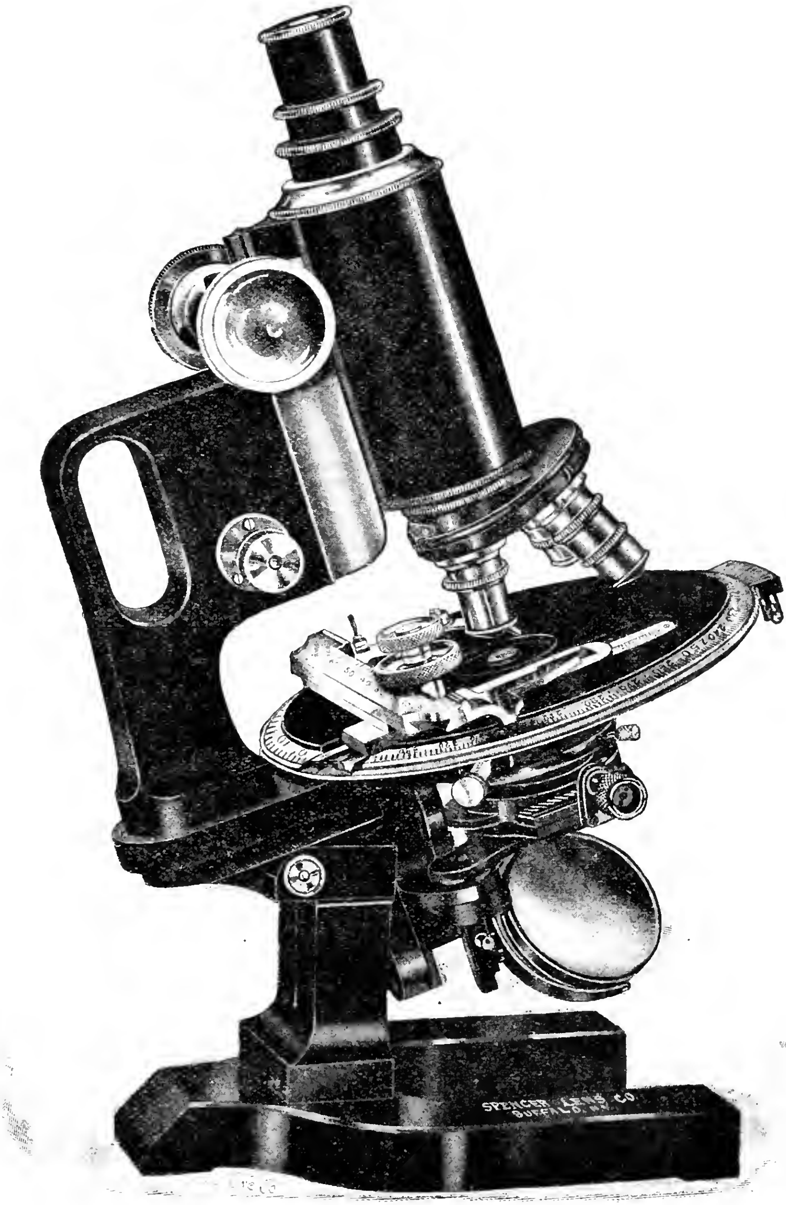



FIG. 35.

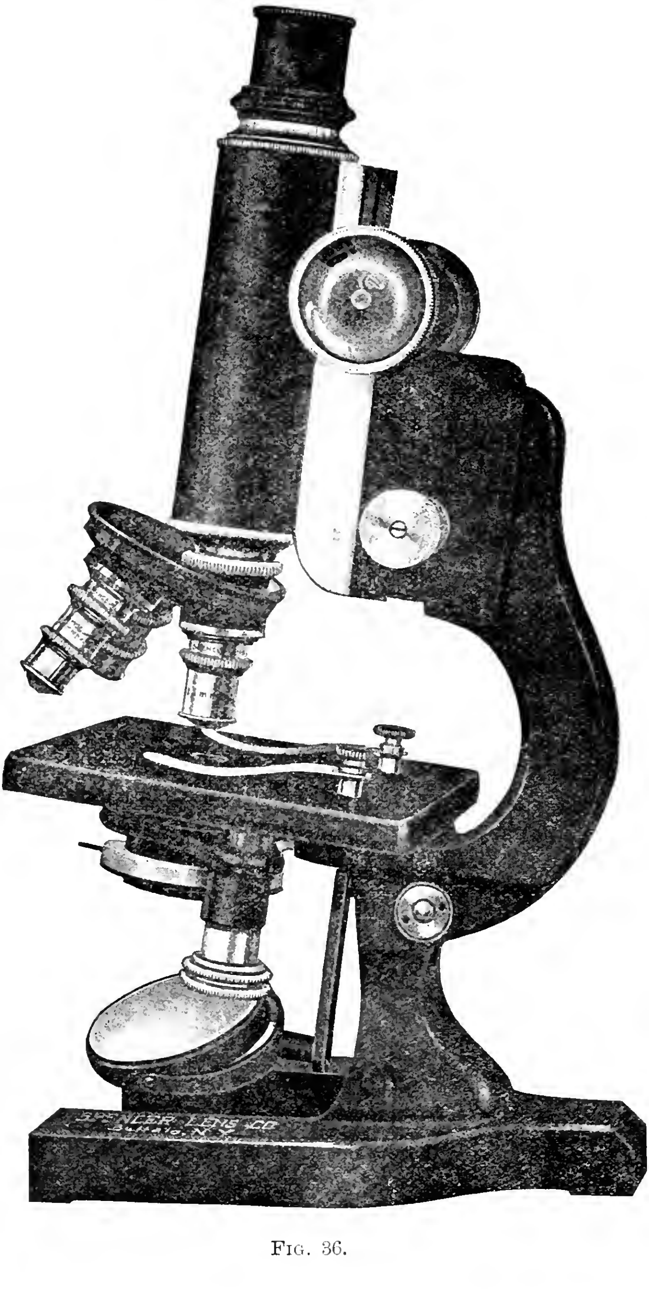



Fig. 36.

**New Spencer Microscope, No. 44.***—This instrument (fig. 36) is intended to be an efficient and comparatively inexpensive type with side fine-adjustment. The arm is large, with a convenient grasp for handling the instrument, and provides a distance of 80 mm. from the arm to the optical axis. The fine-adjustment is of simple type; the thread-bearing shaft has buttons on both ends and passes back and forth through the arm, carrying with it the free end of the longer arm of a bell-crank lever, the shorter horizontal arm of which raises and lowers the body-tube 0·2 mm. for each complete revolution of the shaft. The vulcanite-covered stage is 112 mm. wide and 108 mm. deep, and is provided with a sub-stage of the quick-screw type; the upper iris diaphragm is automatically locked open when the condenser is put into place.

### (3) Illuminating and other Apparatus.

**Improved Apparatus for Dark-ground Illumination in the Early Diagnosis of Syphilis, etc.**†—C. H. Mills describes an apparatus (fig. 37) which at the present time meets the need for a really satisfactory plant for the detection of the *Spirochæta pallida* in the early diagnosis of syphilis. Now, the most rapid and accurate method of detection is by means of the dark-ground apparatus, but the light which is used with this often fails to give sufficient definition. A good knowledge of optics will, no doubt, enable a comparatively feeble source of illumination to be used with satisfaction, but in routine work we do not desire to practise optics so much as to see the *S. pallida*.

With the object of obtaining a thoroughly reliable illuminant, which is easily manipulated and always available without too many preliminaries, the author has for some time been working upon a design which is now completed and accessible to all, being of British manufacture and at a reasonable price.

The following are the special features of the apparatus: 1. Extreme compactness and reliability. 2. Always ready for immediate use, and yet, if so desired, can be returned to the cupboard from consulting-room table or laboratory bench without being dissembled. 3. The hand-fed compensating arc lamp requires the minimum of adjustment. 4. Suitable for use on any existing electric supply—continuous or alternating current—coming within the range of 100–250 volts. 5. Contact is made from a wall-plug or the bayonet fitting of an ordinary electric lamp. 6. The arc projects a good steady light with ample reserve, rendering differentiation between *S. pallida*, *S. gracilis*, *S. microdentium* accurate, rapid, and comparatively easy. 7. Adapted for any type of Microscope stage. 8. The price is reasonable, and the upkeep, even for constant daily use, inexpensive. The carbons for the

* Catalogue, Spencer Lens Company, p. 35.
† Lancet, October 21, 1916, p. 716.

arc lamp are readily obtainable. 9. Each constituent part is capable of an ample range of movement, thus rendering perfect adjustment very simple.

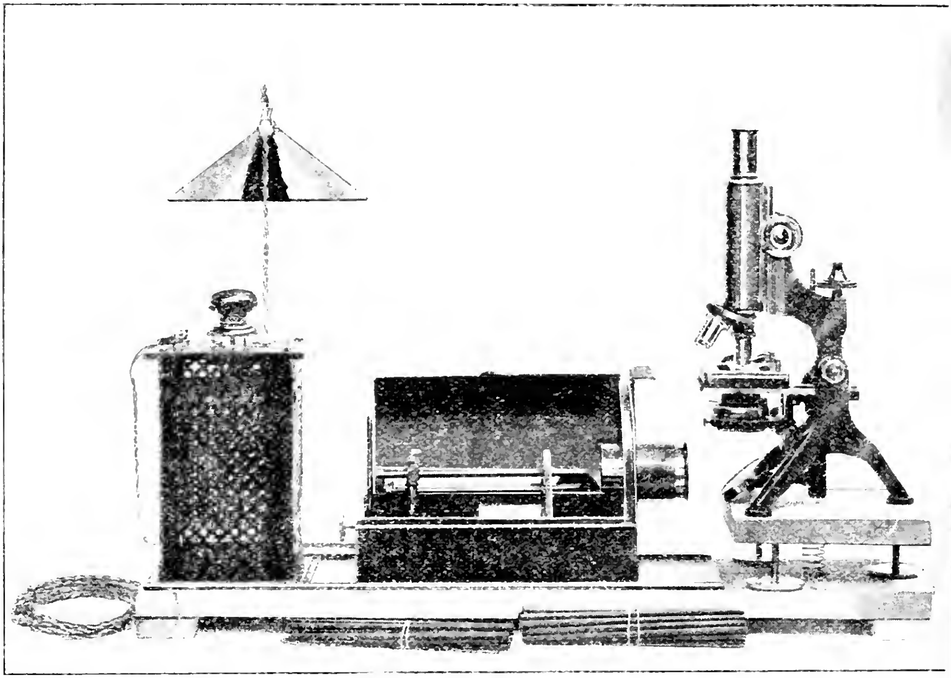


FIG. 37.—On the left: resistance. In the middle: hood of cover laid back to expose the compensating arc lamp, which travels in exact alignment along runners on the base-board. A lens set in an adjustable sleeve is seen projecting. On the right: adjustable stand for the Microscope.

### (4) Photomicrography.

**Wratten Light Filters.***—The Kodak firm have investigated for the purpose of light filters an enormous number of organic dye-stuffs, with which they have been able to prepare a long series of filters of a purity and brightness said to have never before been obtained. These filters are supplied as dyed gelatin film, and are prepared by coating gelatin containing a given weight of dye upon prepared glass, and, after drying, stripping the film from the glass. They are standardized by comparison with a standard whose absorption curve has been measured on a spectro-photometer. The catalogue list comprises nearly

* Wratten Light Filters, Kodak, Limited, London, 1916.

100 varieties ; it also shows their spectro-photometric absorption curves, and also gives their percentage transmission. Some new filters are introduced, including a photometric set, an ultra-violet, and an infra-red.

**Photography of Coloured Objects.***—The second edition of this work includes most of the matter included in the previous edition, together with an incorporation of much of that contained in the Wratten book on "Orthochromatic Filters."

### (5) Microscopical Optics and Manipulation.

**Drawing of Microscopic Preparations.**†—A. Maillefer describes a method of drawing microscopic images with the help of a reflecting prism in a sort of dark chamber. The light from a Liliput electric lamp after passing through a water-cooler traverses an aperture in the wall of the dark chamber and falls upon the objective of the Microscope ; on issuing from the eye-piece a totally reflecting prism projects the image vertically downwards on to the paper placed on the working table. The dark chamber is merely a light framework covered with opaque black cloth, the whole being of such a size as to contain the instrument and the operator. The cloth must be loose and so arranged as to enwrap the operator completely and prevent light from entering the chamber from any direction. Dimensions and details are fully given, and the author expresses great satisfaction with the arrangement.

### (6) Miscellaneous.

**Optical Glass.**‡—W. Rosenhain, in his first Cantor Lecture on the above, points out that the term "optical glass" should be used in such a way as to mean a substance distinguished from even the best of ordinary glass by a whole series of important properties, which can, however, be summed up in two groups: (1) properties relating to "general quality," in regard to which "optical glass" is simply a "better quality" than ordinary glass; and (2) properties of a more specifically optical kind, relating to the refractive and dispersive powers of the glass. Under the first head the subjects of transparency, colour, devitrification, striæ, interaction between the glass and the crucible, internal strain, hardness, and durability, are discussed in a very instructive and interesting way. Under the second head the lecturer treats of refraction, dispersion, and the conditions necessary for achromatic and apochromatic combination.

The second lecture deals with the present modes of optical glass manufacture, and gives the reader some insight into the physical and

* The Photography of Coloured Objects, 2nd ed. Kodak, Limited, London, 1916, 118 pp. (63 figs.).

† Bull. de la Soc. Vaudoise des Sciences Naturelles, li. (1916) pp. 1–7 (1 fig.).

‡ Journ. Roy. Soc. Arts, lxiv. Nos. 3324–6 (Aug. 1916).

chemical difficulties involved. Not the least of these is the selection of materials for the manufacture of the melting-pots; the preparatory seasoning of the clay extends over months, or even years; even when at last moulded the pot requires a further seasoning of some six months. The ingredients of the glass interact upon one another and also upon the pot, which is liable to be rapidly corroded away. The furnace gases are extremely active and introduce many complications. The utmost degree of purity is required in the constituents of the glass. A difficulty from the British point of view is that no bed of sufficiently pure sand exists in Great Britain; but perhaps research might discover one somewhere in the British Empire. The sand required is, therefore, imported into England from Fontainebleau, near Paris. Germany is fortunate in possessing several good sources of pure sand, one of them having a silica-content of 99·98 p.c.

In the third lecture the author discusses possible directions in which the manufacture of British optical glass might be improved and developed so as to make this country independent of German competition. As many of the difficulties are connected with the chemical action of the furnace gases acting on the contents of the pot, and, in many cases, even through the pores of the pot-walls, the author discusses the possible adaptation of a suitable form of electric furnace, in which furnace gases would, of course, be totally absent. Then, if some material could be found suitable for the pot itself which did not chemically react upon the glass, an enormous piece of progress would result. Then there is the question of whether glass is the only crystalline substance suitable for lenses. The author thinks that in this last direction modern research on the synthetic production of suitable crystalline material may come to the rescue. At any rate, for an investigator approaching this subject with adequate resources, a very wide and promising field lies open.

## B. Technique.*

### (1) Collecting Objects, including Culture Processes.

**Automatic Delivery Apparatus for Fluid Media.**†—S. W. Cole says that during the course of bacteriological work undertaken for the Medical Research Committee it was necessary to tube a given amount of broth. For this purpose he devised a piece of apparatus. As will be seen from the sketch (fig. 38), it consists of a stiff rubber ball (D) attached by rubber tubing to a glass part, which contains two light glass valves, accurately ground in. The fluid is placed in the beaker and the rubber ball is squeezed by hand as much as possible. On

* This subdivision contains (1) Collecting Objects, including Culture Processes; (2) Preparing Objects; (3) Cutting, including Embedding and Microtomes; (4) Staining and Injecting; (5) Mounting, including slides, preservative fluids, etc.; (6) Miscellaneous.

† Lancet, Oct. 21, 1916, p. 716.

allowing the ball to expand fluid is sucked up past the valve (B). On repeating this operation two or three times the air is driven out and the whole of the apparatus is filled with the fluid. The ball is then compressed by means of the board, and the position of the screw (C) is found which results in the delivery of the desired amount. Delivery should be made by an even pressure applied as uniformly as possible. It is important to keep the length of the rubber tubing as short as possible and to use thick-walled pressure tubing. Under these conditions the volume delivered is almost independent of the rate of compression of the ball.

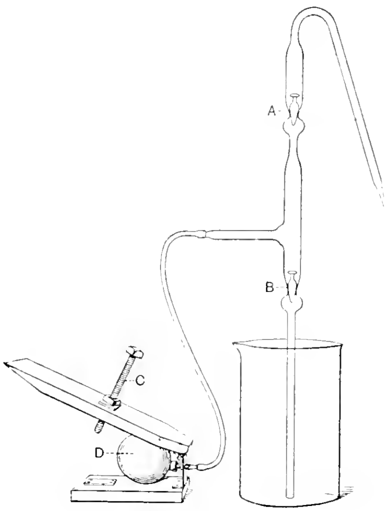



FIG. 38.

**Handling Protozoa in Pure Line Work.***—During the past year R. T. Hance has been engaged in experiments on the inheritance of extra contractile vacuoles in a new race of Paramœcium, and has worked out some methods of technique that have much facilitated his work, e.g. maintaining pure cultures. The greatest care is necessary to prevent pure line cultures from becoming mixed with others. Even with labelled pipettes accidents may occur. The scheme shown (fig. 39) was recently devised and has proved most convenient. A piece of soft brass wire is shaped about some round object of a diameter slightly larger than a pipette, and is held by several twists. Then the long ends of the wire are bent around the culture jar and again fastened by twisting the ends. In the jars used there is a convenient groove near the top into which the wire fits nicely. When finished the small circle

* Trans. Amer. Micr. Soc., xxxv. (1916) pp. 135–6 (1 fig.).

protrudes from the jar, and into this ring the pipette is dropped, giving the appearance seen in fig. 40. With this method pipettes are always at hand and there is no danger of mixing the lines by transferring animals from one culture to another.

*Preparation of Watch-glasses.*—Syracuse watch-glasses have been used for single individuals throughout the work, and considerable difficulty was experienced at first in locating animals which were close to the edge of the container. They frequently found their way there, as the fluid had a tendency to spread evenly over the surface of the watch-glass. The best method to obviate this was hit on accidentally. There was a trace of paraffin in a pan in which the glasses were being sterilized one day, and this coated the glasses imperceptibly, but sufficiently to give the liquid no hold on the glass. In vessels treated in this way the surface tension of the medium tends to draw it into a

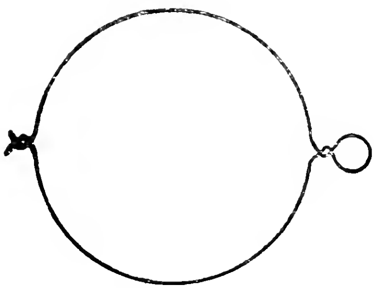


Fig. 39.

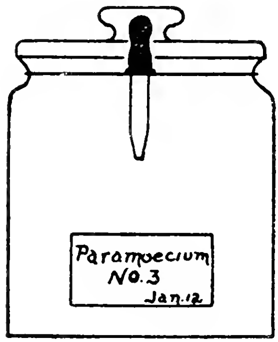



Fig. 40.

spherical mass. Should the liquid roll to the edge of the glass, where the animals would be hidden from view, it is easily rolled out again by tilting the glass, and none of the animals in the drop are left behind. When animals are being kept in very small drops of water, as many as twenty individual drops of liquid containing Protozoa may be placed in a single watch-glass and they have not ran together. The surface tension of the liquid draws it up when on a paraffined surface until it gives a very fair picture of a drop of mercury. Furthermore, being contracted to the smallest area possible, there is less evaporation than when the same amount of fluid is spread out, and the chances of losing a valuable specimen through drying are much less. The writer's practice is to use a piece of paraffin about the size of a pea to a quart of water. This will be sufficient for a surprising number of watch-glasses. When the sterilized glasses are removed they are wiped while hot and polished. No paraffin is visible, although a faint trace of it can be felt.

**Collecting and Rearing Volvox.***—G. R. La Rue collected Volvox in the autumn of 1915, and in the spring of 1916 found they had multiplied freely. He gives certain cautions—e.g. the water for the cultures should be from the same source as the organisms. Tap-water for making up the culture or for making good evaporation should never be used. Keep the cultures covered to prevent evaporation and consequent change in density of the medium, and to exclude dust and bacteria. The presence of organic material seems to be beneficial. Direct sunlight is unnecessary and is to be avoided, because it causes too great variations in temperature in closed vessels. North light is good: in fact many algæ thrive in it. Low temperature, above freezing, seems to favour development. Old cultures, unless hopelessly foul, should be kept, and the organisms given a chance to reappear.

**New Solid Medium for the Isolation of the Cholera Vibrio.**†—H. G. Gibson gives the following formula for the preparation of this medium: Agar, 3 grm.; pepton, 10 grm.; starch, 10 grm.; sodium bicarb., 1·5 grm.; litmus (sufficient to colour medium); water, 1000 c.cm. Weigh out 30 grm. of powdered agar and emulsify with 250 c.cm. of cold water. Then weigh out 10 grm. of pepton and 1·5 grm. of sodium bicarb. Mix together and emulsify in another 250 c.cm. of cold water. The two emulsions are then mixed in a two-litre flask and 500 c.cm. of water added. The solution is completed in a steamer. When dissolved the medium is clarified with white of egg and filtered in the steamer. Weigh out 10 grm. of potato starch, emulsify it with some of the filtered agar, and add the emulsion to the remainder of the medium. The whole is sterilized by the fractional method, after which enough sterile aqueous solution of litmus is added to bring about a blue colour of the medium. The final reaction of the medium should be: 2 to phenolphthalein; 0·15 p.c. sodium bicarb. gave the best results.

Examination of the plates eighteen hours after inoculation showed the cholera colonies to be pink, the other colonies to be blue or whitish. In twenty-four to twenty-six hours the cholera colonies are pink, with a faint pink halo. In forty-eight hours other colonies may be pink, but the cholera colonies may be distinguished by their red centres which the other colonies lack. The only other organisms which are known to acidify starch are some of the diphtheroia group and some of the non-pathogenic water vibrios. Gram's stain and the serological test dispose of these organisms.

**Acidification of Culture Media by Alkaline Salts.**‡—L. Bourdet has investigated the question of the acidification of culture media by means of their contained alkaline salts during sterilization in the autoclave. The acidification is produced by action of certain salts upon sugars and peptons contained in the different media: for example, the

* Trans. Amer. Micr. Soc., xxxv. (1916) pp. 150-1.
† Brit. Med. Journ., Sept. 30, 1916, pp. 454-5.
‡ C.R. Soc. Biol. Paris, lxxix. (1916) pp. 665-8.

alkaline salts of milk produce formic acid at the expense of the lactose when milk is heated to 130° C. The differentiation of organisms by means of sugar media is rendered difficult by this fact, a slight degree of fermentation being simulated. Bourdet recommends in practice that (1) broth media should be sterilized by filtration after the addition of the pepton and the alkali; (2) separate sterilization of the sugars required for the media, and their aseptic admixture with the broth media; (3) the separate sterilization of the litmus solution.

**Culture of Diphtheria Bacilli in Veillon's Tubes.***—L. Martin and G. Loiseau recommend the following technique for the differentiation of true diphtheria bacilli from pseudo-diphtheria bacilli. It is based on the fact that *Bacillus diphtheriæ* is a facultative anaerobe, while the other organisms are strict aerobes.

The medium employed is prepared as follows: 250 grm. of minced veal added to 500 c.cm. water are mixed with equal parts of "bouillon de panse (pepton martin)." To each litre of this mixture is added: Agar 8 grm. glucose 15 grm., and potassium nitrate 2 grm. Dissolve and add the white of one egg, heat to 115° C. for half-an-hour, filter, tube, and sterilize for half-an-hour at 100° C., and, during the three days following, for half-an-hour at 115° C.

A pure colony of the organism to be investigated is emulsified in a tube of 10 c.cm. broth. The organisms are then well distributed by shaking. Add 1 c.cm. of this emulsion to a tube of the glucose agar medium (previously boiled and cooled rapidly to 50° C.) and mix carefully. Incubate when solid. True diphtheria bacilli are easily identified, as the colonies are evenly distributed throughout the tube without prominence in the aerobic zone, while colonies of *B. Hoffmann* and other diphtheroids only grow in the superficial zone, and not in the strictly anaerobic portion of the medium; moreover, the growth is less rapid than with the diphtheria bacillus, and is not generally visible for at least twenty-four hours.

**Digested and Diluted Serum as a Substitute for Broth.**†—A. Distaso suggests the use of the following medium in the place of ordinary broth in bacteriological work: (1) One volume of sheep or ox serum is mixed with one volume of tap-water, and boiled till it becomes milky. (2) A pig's pancreas is minced and extracted with 400 c.cm. of distilled water in the presence of chloroform for twenty-four hours; and (3) a piece of the upper part of the small intestine is extracted in the same way, in order to activate the pancreatic extract. To one litre of (1) is added 100 c.cm. of (2) and 10 c.cm. of (3), and digested at 60° C. for the night. Next morning the flask contains an amber-coloured liquid with fine flocculi floating in it. Filtered through Chardin paper, the amber-coloured liquid passes through, and the flocculi remain in the filter. The liquid is collected and sterilized at 120° C. for fifteen minutes, then tubed and re-sterilized. In this medium the

* C.R. Soc. Biol. Paris, lxxix. (1916) pp. 677–80.
† Brit. Med. Journ., 1916, pp. 555-6.

growth of the *Bacillus coli* group, the streptococci, *B. subtilis*, *B. proteus*, and *fluorescens*, is so luxuriant that in comparison normal broth may be said to give a scanty growth.

### (3) Cutting, including Embedding and Microtomes.

**Spencer Automatic Laboratory Microtome.*** — This apparatus, numbered 880 in the maker's catalogue, is shown in fig. 41. In this microtome the main supporting frame has a heavy clamp at the back by which it is securely fastened to the laboratory table. As will be seen from the figure, the upper part of this frame forms a support to which the two laterally swinging arms are attached by steel pivot screws with check nuts. The knife-carrier is held by these swinging arms at their outer ends, attached thereto by similar pivot screws with check nuts, and in order to give the proper movement, relieved from any pressure or strain, a detachable flexible lever handle is attached to the axis fastened to the longer arm on which the arm swings. The extreme ends of the knife rest in the holder, and, as the lever moves the swinging arms, the blade describes the flattened curve, corresponding to the double movement in free-hand sectioning. By this manner of holding the knife by arms, which are not parallel, the entire length of its cutting edge is utilized, insuring uniform wear and permitting the cutting of larger sections than has heretofore been possible, except by using a very much larger blade. The swinging arms and knife-holder are sufficiently rigid to avoid any deflection of the knife in its movements ; thereby assuring uniformity of thickness in all the sections. This peculiar motion of the knife makes this microtome especially desirable for cutting frozen sections. Sections may be cut, stained and mounted in one and one-half minutes from the time the tissue is placed on the freezing plate. This microtome does excellent work with celloidin also. The movement of the knife is not so well suited to paraffin work, but it does very well with this medium.

Another important advantage in this method of construction is its convenience to the user. In most microtomes with sliding parts, these require frequent lubrication with oil, and in consequence are liable to be clogged with dirt, requiring frequent cleaning, and also to become loose and shaky. In this microtome, lubrication is not required, and in its construction every joint is provided with pivot screws and check nuts, and by means of a steel pin sent for the purpose the owner may take the instrument apart and adjust or clean it as occasion may require. The object-clamp for paraffin or celloidin blocks has a pin or round shank which may be fastened by a clamp screw in a vertically movable socket which is supported by two vertically swinging arms attached at the back to the main frame by hardened steel pivot screws. Similar pivot screws at the front hold the socket in the swinging arms: thus providing for its vertical movement the same parallelogram principle as is applied to the knife. By this means, a steady movement is secured and the top of the object always remains in the same horizontal position ;

* Catalogue, Spencer Lens Company, p. 113.

thus further insuring uniformity of thickness in the sections. The object-clamp-supporting socket is raised or lowered by a vertical feed

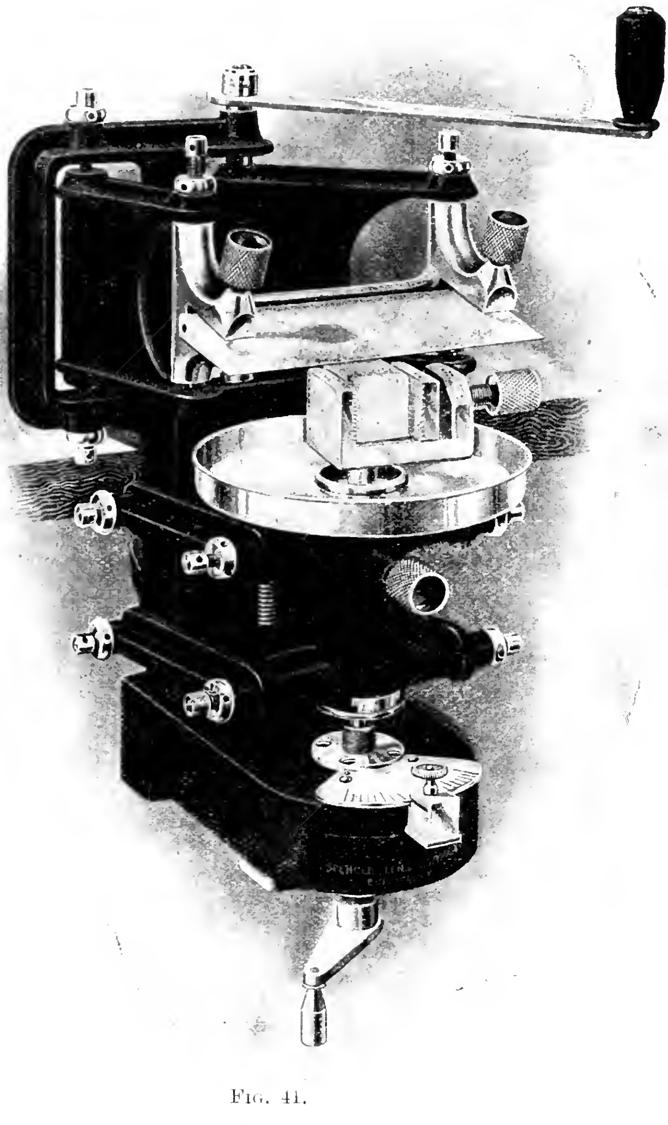


FIG. 41.

screw with fine micrometer thread, having a crank at the bottom for independent movement. This screw is firmly held in double nut

bearings which provide for taking up lost motion and for eliminating any wear that may occur. At its upper end this feed screw is connected with the object-supporting socket by means of a ball-socket bearing, to which the object-support is firmly held down by a strong steel spiral spring. The automatic feed mechanism consists of an accurately cut ratchet wheel, keyed to the vertical feed screw, in the teeth of which a hardened steel pawl engages. By means of a lever, extending to the graduated scale shown on the front of the main frame base, this pawl may be thrown out of action by turning the index finger to the extreme left, or it may be set to cut sections of any desired thickness. Each division of the graduated scale marks 5 microns. A long, vertical shaft, extending to the lever arm at the top of the main frame and connected at the bottom by a simple lever device, moves the pawl backward and forward simultaneously with the movement of the knife, so that wherever the index is placed on the graduated scale, the object is correspondingly raised at each swing of the knife. The crank at the bottom can be used independently of this automatic motion and provides for quickly raising or as quickly lowering the object whenever desired. The whole feed mechanism is simple in construction, and, being covered by the extended base of the main frame, is protected from dust and drippings. It may easily be reached from below and it cannot easily get out of order. A convenient drip pan, at the top of the socket in which the object-clamp sets, may be quickly unscrewed and as easily replaced. It is best to remove it when the freezing chamber is attached. This is heavily nickel-plated, as are all the screws and exposed parts.

**Embedding in Paraffin.***—R. T. Hance says that when embedding very small objects, such as insect larvæ or small flowers or anthers, in paraffin it is most convenient to orient them one behind the other. This method allows a single block to be made of three or four to a dozen pieces of tissue, and these may be cut in one ribbon. This obviously eliminates a great deal of the labour in making a block for each separate object, cementing it to the holder, trimming it, and adjusting the microtome each time. In the ribbon it is easy to see where one piece of tissue ends and the other begins, as there are usually several blank sections of paraffin between them. It is relatively simple to arange the tissue in line under a carbon bulb with warm needles, but a difficulty is met with when an attempt is made to place the paraffin mould in water for cooling. The material is shaken from position, and must be re-oriented. This has been overcome in the following way. A watch-glass is used as a mould for embedding small objects, and a Petri dish is convenient for larger tissue. When the tissue is ready to be embedded, the dish is heated to the melting-point of the paraffin under the electric bulb. It is then placed in a crystallization dish, with two slides beneath it to prevent it from touching the bottom of the container. Paraffin is then poured into the small dish, and the objects oriented as desired, the heat of the electric bulb keeping the paraffin melted. Then the light is turned off, and cold water is poured into the

* Trans. Amer. Micr. Soc., xxxv. (1916) pp. 137–8.

crystallization dish. Since the dish containing the paraffin is raised from the bottom the water flows under it, and soon solidifies the paraffin in the lower part of the dish, which consequently holds the object fast. As soon as a surface film is formed, enough water can be added to cover the embedding mould to complete the hardening of the paraffin. In Petri dishes or watch-glasses the bottom is practically flat and true, and the tissue is allowed to sink to the bottom. When the tissue is cut out as a block, the part that rested against the bottom makes one of the two parallel sides, and requires little or no trimming.

When a number of pieces of tissue or a number of series are embedded in one disk of paraffin, it is dangerous to attempt to separate them with a knife, as one can never be sure of the direction the crack in the paraffin will take. The writer has found that a hand scroll-saw or coping-saw does admirably for cutting a block of tissue from the main disk. The use of the saw permits many more pieces to be placed in the same space, and no care need be taken to have well-defined pathways for the paraffin to split along, as is necessary when a knife is used for separating the pieces.

**New Embedding Stage.***—G. R. La Rue says the essential parts of this embedding stage (fig. 42) are a transite base, 17¾ in. long by

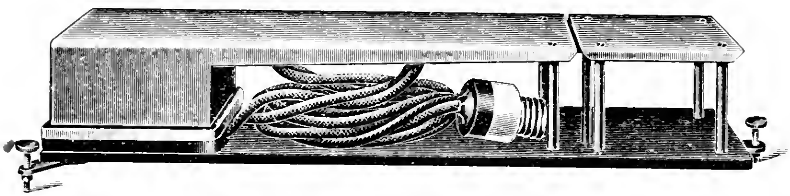


Fig. 42.

½ in. wide, mounted on three levelling screws, a copper stage made in two parts, 4 by 13 in. and 4 by 4 in. respectively, and under one end of the longer copper stage an electric heating unit. The heating unit may be wound for any voltage and to yield any desired temperature. No regulator or rheostat or other provision for controlling or varying the temperature is provided, but since the coil is situated under one end of the stage lower temperatures may be secured by moving the object away from the coil. In practice the coil is attached to a convenient electric receptacle near the paraffin bath, and that part of the stage over the coil is heated sufficiently to melt paraffin in a few minutes. The embedding tray may now be warmed over the hot stage, filled with melted paraffin and moved to a point on the stage where the paraffin is kept just melted. Objects to be embedded are now transferred to the embedding tray, oriented, and the label inserted at the end of the tray with the legend towards the margin of the tray. Now the tray is gently moved to the unheated end of the stage, where the paraffin is permitted to congeal on the bottom sufficiently to hold the objects in

* Trans. Amer. Micr. Soc., xxxv. (1916) pp. 154–5 (1 fig.).

place. Then the tray is transferred to a dish of cold water or alcohol standing at the end of the embedding stage, and into which it is immersed as soon as the paraffin is cooled sufficiently to prevent the breaking of the surface by the water.

The use of this embedding stage secures good embedding, because the paraffin is melted clear to the bottom of the tray, and thus orientation is made easy.

### (4) Staining and Injecting.

**Method of Staining Flagella.***—L. Tribondeau, in collaboration with M. Fichet and J. Dubreuil, has evolved a simple procedure for staining bacterial flagella. The bacteria are grown on Martin's agar 2 p.c. (slightly alkaline) in Petri dishes. After twelve hours' incubation a colony is picked off and emulsified in distilled water. Cover-slips are boiled in bichromate of potash 50 grms., sulphuric acid 100 grms., water 1000 grms., and then washed in tap-water; dry and flame in the Bunsen burner, wash the flamed surface with distilled water, and dry vertically without wiping. A drop or two of the bacterial emulsion is allowed to spread itself over the cover-slip, and when the film is dry it is fixed rapidly with absolute alcohol. Staining: Solution of tannin, 10 parts per 100 in distilled water 1 part, saturated solution of potash alum in distilled water 2 parts. Boil rapidly, add 0·5 c.cm. alcoholic solution of crystal violet (stock solution, 2 parts in 10 of alcohol 1 part, absolute ethyl-alcohol 10 parts), mix and bring again to the boil, mix again and cover the surface of the films very rapidly and allow to act for from fifteen to thirty seconds. Wash rapidly under the tap, dry and examine with the oil-immersion lens. The flagella are coloured blue-violet.

**Cultural Vital-staining of Bacteria.**†—T. Iwao says that the following medium gives good results: To hot filtered agar, made alkalin with sodium carbonate, are added 0·3 of "eosinsaures" methylen blue. The agar solution is carefully shaken and then distributed in test tubes, 10 c.cm. in each. After this they are sterilized for one hour at 100° C. The staining of the bacteria, especially of the coli group, is good, the granules coming out well.

### (5) Mounting, including Slides, Preservative Fluids, etc.

**Slide for Examining Small Pond Life.**‡—E. M. Nelson describes a new form of slide, and also describes the apparatus required. First, an oil-immersion sub-stage condenser on dark-ground illuminator. Second, two slips, 3 by $1\frac{1}{4}$, cemented along their bottom edges to make a ledge. A drop of the gathering is put with a pipette in the

* C.R. Soc. Biol. Paris, lxxix. (1916) pp. 710–16.
† Acta Schol. Med. Univ. Imp. Kioto, i. (1916) pp. 251–62 (1 pl.).
‡ English Mechanic, Sept. 29, 1916, p. 191.

hollow and a large cover-glass is placed over it (Fig. 43). If the cover-glass projects just over the top of the slip it is easy to lift it off. When the slip, duly charged with the gathering, is on the stage of an inclined Microscope the cover-glass will not slip off, because it will be held by the ledge, neither will the small excess of water, squeezed out between the cover and the slip, run down on to the stage, because the ledge will catch it.

The writer, who is indebted to W. Chaffey for this simple and excellent device, has now used it for some time in preference to the different forms of compressors that are made. One point is that these slides should be of a proper thickness to suit the focus of the sub-stage illuminator; for if the focus of the illuminator is long and the slide thin there will be constant trouble, because the oil will run away, and a slip-equalizer must be provided. If the slip is thick and the focus of the illuminator be short the illumination will be very poor indeed. It is better, therefore, in the first instance, to find the precise working

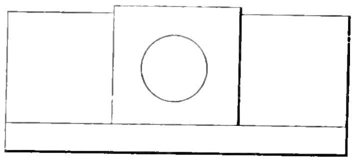


FIG. 43.

distance of the illuminator and provide a slip of a proper thickness to suit it, then the maximum amount of illumination will be secured and no further trouble experienced. Note, with the above objectives and deep eye-pieces of 1 or a ½-in. focus the focused image of the edge of the flame of a paraffin Microscope lamp (used direct if the Microscope stands high on its trunnions, but with the plane mirror if low) will yield a very satisfactory and critical illumination.

**Method of Making Toto Mounts of Unicellular Forms.***—R. A. Nesbit describes the following procedure: The material is killed and fixed in whatever solution the investigator has found most satisfactory for the particular Algæ or Protozoa with which he is working. It is washed in bulk in the usual manner and carried through upgraded alcohols as far as 60 p.c. It is allowed to settle completely in this grade. A thin layer of albumen fixative is smeared on thoroughly clean slides. A drop of the material is then drawn up with a pipette and placed on the slide. The alcohol coagulates the albumen and causes the cells to adhere to the slide. They may then be dipped into 60 p.c. alcohol and afterwards to upgraded alcohols. It is possible to use such stains as Flemming's and iron-hæmatoxylin rapidly and with precision. Before using Flemming the cells must be hardened in 95 p.c. alcohol.

* Trans. Amer. Micr. Soc., xxxv. (1916) p. 140.

### (6) Miscellaneous.

**Cleaning used Microscope Slides.***—J. T. Illick gives the following method: A liberal amount of gold dust and a number of slides were placed in water and thoroughly boiled. As soon as the cover-slips came off of their own accord the slides and slips were placed in a pan of water. These were wiped dry while others were being boiled.

## Metallography, etc.

**Alumina in Steel.**†—The question of the occurrence of alumina inclusions in steel and their detection by the Microscope has been studied by A. Sauveur, by (1) producing thermite iron with an excess of aluminium: (2) melting ingot iron with aluminium; (3) melting ingot iron with alumina. In each case polished but unetched sections of the metal exhibited under the Microscope, at a magnification of 300 diameters, small, dark and roughly rounded particles scattered throughout the iron. Characteristics of alumina inclusions, by which they may be distinguished from other non-metallic inclusions generally occurring in steel, are their dark colour, small size and complete absence of any elongation in the direction of rolling or forging. This agrees with the known brittleness and infusibility of alumina.

**Study of Cooling Rates with a Chromium Steel.**‡—C. A. Edwards heated cubes of a steel containing 0·63 p.c. carbon and 6·15 p.c. chromium to 1147° C., and cooled at varying rates. A critical rate of cooling was found—namely, twelve minutes sixteen seconds—from 836° C. to 546° C. For all slower rates of cooling, recalescence occurred during the cooling, and the hardness produced was very similar. When the rate of cooling is quicker than the critical rate, the thermal change is much modified, or, with very quick cooling rates, repressed altogether, and the steel is progressively hardened, according to the quickness of the cooling. The critical cooling-rate varies with the initial temperature of cooling. The higher the initial temperature, the slower is the critical rate of cooling. Photomicrographs of structures of the steel corresponding to different rates of cooling are given. Samples cooled at rates slower than the critical rate, and therefore not self-hardened to any appreciable extent, consisted generally of troostitic pearlite, with very little martensite. Samples cooled quicker than the critical rate contained large quantities of martensite, which is responsible for the self-hardening. When the cooling was sufficiently rapid to suppress altogether the thermal change and produce maximum hardness, the structure was all martensitic.

**Corrosion of Steel.**§—L. Aitchison discusses the mechanism of corrosion in pure iron and the various kinds of steel. In steels

* Trans. Amer. Micr. Soc., xxxv. (1916) p. 141.
† Metall. and Chem. Engineering, xv. (1916) pp. 149–51 (4 figs.).
‡ Journ. Iron and Steel Institute, xciii. (1916) pp. 114–40 (8 figs.).
§ Journ. Iron and Steel Institute, xciii. (1916) pp. 77–91 (6 figs.).

corrosion is considered to be an electrolytic action between the carbides and the carbon-free material (ferrite or solid solution) which together constitute the structure of the steel. The carbides act as anodes of the electrolytic couples, and are therefore preserved while the ferrite or solid solution is attacked, and passes into solution in the corroding medium. Photomicrographs of (1) steel containing 1·25 p.c. carbon, and (2) steel containing 0·73 p.c. carbon and 21·5 p.c. tungsten, after corrosion are given to illustrate this point. Each shows massive carbide intact. In a similar way, pearlite does not corrode as a whole, but as a mixture of ferrite and carbide, and only the ferrite is attacked. The disappearance of the carbide from pearlite which usually occurs in corroding pearlitic steels is due to mechanical loss. In the case of pure iron, consisting of ferrite only, electrolytic action between the ferrite crystals and the intercrystalline amorphous cement is put forward as the chief cause of corrosion. Here the amorphous material acts as kathode, and passes into solution more rapidly than the ferrite. Evidence of this is shown in a photomicrograph of pure iron after corrosion in sodium chloride solution, showing accelerated action along the crystal boundaries. The concentration of the solid solution is the controlling factor in deciding the rate of corrosion of a steel, since the higher the concentration the lower is the electromotive force set up by the solid solution in a corroding medium. The properties of special steels are reviewed, and shown to confirm these views. Elements like molybdenum, vanadium, and tungsten, which form part of the carbide and do not enter into the solid solution until a high percentage is present, exert little effect on the rate of corrosion, while elements such as chromium and nickel, which enter into solid solution from the first, retard corrosion.

**Surface Tension Effects in Metals.***—A theory, based upon the existence of films of metallic amorphous material or cement between the crystalline grains of metals, is elaborated by F. C. Thompson. This amorphous material is regarded as an under-cooled liquid, and the deduction made that surface tension forces operate between crystals separated by thin films of such material. The great and unexpected strength of the crystal junctions in ductile metals is associated with these surface tension forces. The growth of crystal grains at high temperatures during annealing is explained by the endeavour of these surface forces within the mass of metal to reduce the area of the intercrystalline boundaries. The mechanical and other properties of metals are considered and interpreted in the light of these ideas. The elastic limit of a metal is reached when the attraction of the surface tension forces over a given area of a specimen under test is just overcome. The larger area over which surface tension attractions can occur provide an explanation of the well-known fact that a fine crystal structure possesses a higher elastic limit than a coarse crystal structure. The equation $E = \frac{2T}{d}$ (where E = elastic limit, T = the surface tension of the amorphous material, $d$ = thickness of the film) is deduced. Accurate

* Journ. Iron and Steel Institute, xciii. (1916) pp. 155–92 (7 figs.).

determinations of the elastic limit of a series of pure metals were made. while values for the surface tension of the amorphous material, based upon measurements of the surface tension of the molten metal at its melting-point, are deduced. Applying these results in the above equation, values are obtained for the thickness of the intercrystalline films in the various pure metals examined. An application of the theory is illustrated by a study of a steel shaft which had been drastically over-annealed and showed very low elasticity. Samples of the same steel when heat-treated by (1) normalizing at 850° C., (2) heating to 850° C., quenching in oil and tempering at 350° C., showed similar elastic limits, each much higher than that of the over-annealed sample. Photomicrographs of the steel in the three states are given, showing a large crystal size for the over-annealed and a much smaller and about equal crystal size for the two other samples. The calculated thickness of amorphous film is four times greater in the over-annealed sample than in the two others, and its low elasticity is readily understood, since the thicker the film the lower the magnitude of the surface tension forces. The tensile strength of the three samples was of the same order. The factors governing this property depend on the crystals themselves, and not, as in the case of the elastic limit, on the nature and extent of the intercrystalline junctions.

# PROCEEDINGS OF THE SOCIETY.

## AN ORDINARY MEETING

OF THE SOCIETY WAS HELD AT NO. 20 HANOVER SQUARE, W., ON WEDNESDAY, OCTOBER 18TH, 1916, MR. E. HERON-ALLEN, F.L.S. F.Z.S., ETC., PRESIDENT, IN THE CHAIR.

**The Minutes** of the last Meeting, having been circulated, were taken as read, and signed by the President.

**The President** said that the question had arisen, at the meeting of the Council, as to the hour of meeting. It was quite obvious that under the circumstances at present ruling — the meetings commencing at 8 p.m. and terminating at or beyond 9.30 p.m.—it was very difficult for a number of Fellows to attend. It was, therefore, suggested that the hour should be altered temporarily; and if the approval of this large and representative gathering was obtained, it was proposed, by an Order of the Council, to make the alteration to 5.30 p.m. during these very dark winter months. He asked for a show of hands in favour of the temporary change of hour.

A large majority having voted in favour, **Mr. Blood** asked whether there was to be a discussion on the proposal.

**The President** replied that the discussion should take place at the next Meeting. It was proposed to issue the next notice for 5.30 in the afternoon.

**Mr. Blood** vehemently protested against such action, which would disfranchise a certain number of Members. If a vote was to be taken, it should be at a Meeting called at the ordinary hour, otherwise a number could not participate.

**The President** replied that in view of the attitude of Mr. Blood it was obvious that the situation could not be met by a temporary "Order of the Council," therefore the matter would not be proceeded with at the present Meeting.

**The President** announced the following donations to the Society :—

| | From |
|---|---|
| A small French Microscope, and a $\frac{1}{4}$-in Objective by Wheeler .. | *Mrs. Owen.* |
| Moor, C. G., and Partridge, Wm., "Aids to Bacteriology." 3rd ed. 1916 .. .. .. .. .. .. .. .. .. .. .. .. .. | *The Publishers.* |
| Assheton, R., "Growth in Length." Embryological Essays. 1916 | *The Publishers.* |

He was sure it would be the wish of Fellows to return their thanks to the generous donors. Carried.

A paper by **Dr. Helen Pixell Goodrich** and **Miss M. Moseley**, entitled "Certain Parasites of the Mouth in Cases of Pyorrhœa," was then read, Dr. Goodrich demonstrating, by means of a series of lantern slides, the results of the authors' investigations.

**Sir E. Ray Lankester, K C.B., F.R.S.**, said it had given him great pleasure to listen to this communication; he knew that the authoresses were engaged upon this work, and he was aware of some of their investigations and found them of very great interest. The question of the cause of pyorrhœa was one of much importance. The idea that amœbæ were responsible was prevalent when these ladies took up their work, but he thought their view that the cause did not lie here would be generally accepted. The study of the leptothrix they had described was extremely interesting: it required careful and considerate treatment, since it was a well-grown organism, and had a good deal of character about it.

The whole history of freely growing bacteria was one of great interest, and had a close bearing upon medical pathology. Of course, this creature in the mouth was very much like some of the organisms concerned with calcifying springs, those hot-water springs which were found in this and other countries, where they produced a deposit of much calcareous matter. There had always been two opposed attitudes in regard to bacteria—the one regarded every small form of bacteria which could be isolated and made to exist by itself for a time, as a distinct species or even a distinct genus. The other, in which he included himself, considered that under slightly different conditions of nutriment, bacteria might undergo very great changes in mode of growth, and even in mode of movement and general shape. This was what was called, at the commencement of the investigation, the pleomorphic view, the view which he was pleased to find the authoresses of this paper took in regard to the buccal organism they described.

A point of great interest in this matter was that in dealing with these more free-living bacteria, one was led rapidly through the begiatoas and leptothrix and other such genera to a group of organisms known to microscopists—namely, ostoria—to which group several genera belonged. His belief, though he did not think many medical bacteriologists shared it, and some perhaps opposed it, was that the ostoria were peculiar in their feeding, peculiar in their chemistry, and were altogether a peculiar group of green algæ. Many of the ostoria contained chlorophyll, as well as other colouring matter. The bacteria were only a specialized group, which had gone further. They exhibited the long filamentous forms, but also exhibited coccus forms and short bacillary forms; their nutrition had become limited by the conditions in which they lived. They had lived in rich fluids containing large amounts of mineral matter; and, living in special conditions of that kind, bacteria had made their way from the outside of organic bodies to the inside, losing their colour, and then losing much of their variety of growth. Those were points of interest connected with leptothrix and the similar bodies which were found in natural fresh waters. He was extremely glad that these gifted ladies had taken up the subject, and hoped they would carry it on, and in doing so have in mind not only the desira-

bility of stopping an unpleasant disease, but also the great question of the connexion of the bacteria dealt with, with other groups, such as the ostoria, since there was a laige field open for such work.

**Dr. John Eyre** said that pyorrhœa was a subject to which he had devoted intermittent attention for some fifteen or eighteen years, and he was delighted to find himself largely in agreement with the opinions expressed by the authors of the evening's paper, particularly when they scoffed at the idea that amœbæ were the cause of pyorrhœa.

His own opinion coincided with theirs, that pyorrhœa was the direct result of gum infection—i.e. a direct inoculation of the virus, whatever it might be, into the gum tissue, generally by the aid of some sharp lacerating instrument, such as a spicule of bone, a bristle from a tooth-brush, or a scaling instrument, and the resulting inflammation resembled that occurring in other fibrous and bony tissues, plus certain modifications due to its anatomical position. Moreover, as it was well known that the ordinary pyogenic bacteria which caused pus in other situations would give rise to suppuration in the gum and alveolar process, he considered they were the probable cause of most cases of pyorrhœa.

He was anxious to know whether the cases in the lower animals from which the authoresses obtained their excellent sections were artificially produced, or whether they were selected natural infections; and, if the former, how the authors were able to keep up the infection experimentally so as to secure the late stages of the disease. He had himself tried many times to produce pyorrhœa artificially in the rabbit and guinea-pig, but, so far, had only succeeded in producing a transient marginal gingivitis. Of course, he had seen cases of pyorrhœa occurring naturally in animals, but considered it was difficult to get a series of sections of the beauty of those Mrs. Goodrich had shown.

With regard to the possibility of the author's pleomorphic leptothrix being a possible source of the *Bacillus fusiformis* of Vincent, he did not think that assumption would prove to be correct, since the fusiform bacillus had been cultivated and had bred true in culture media from generation to generation; it had never developed either into spirochæte on the one hand, nor into leptothrix on the other.

He would like to hear Mrs. Goodrich's opinion of Nogouchi's work on the spirochætes as the cause of pyorrhœa.

**Mr. E. J. Sheppard** said that after some twenty years beside the dental chair he could not resist the personal conclusion that, excluding the leptothrix theory, the expounding of which had interested him greatly, far too great importance was attached to the bacterial theory of the causation of pyorrhœa. The development of tartar as a cause he also thought was over-rated. He considered it due to some altered metabolism of the cells, a view which had not received due attention. Though a dentist, he was himself subject to pyorrhœa, and to rid himself of it he had tried everything at his disposal. Yet he was still as far from cure as when the condition first developed. In connexion with the view as to a systemic cause, he believed a wide field was open for the practice of vaccine therapy.

**Dr. Leeson** thought there was a constitutional element in pyorrhœa

equally as important as the local one; it constantly occurred in those who were in poor health and varied with their general condition. He was surprised to learn cats and dogs suffered from pyorrhœa. If the cause was purely traumatic, surely *all* such animals should suffer, as their food abounded in sharp particles. If the disease was essentially parasitic, how did habitual smokers fare, as nicotine was regarded as a germicide? Dr. Leeson inquired if the authors had any practical suggestions likely to be of value to sufferers from this disease.

**Dr. A. H. Drew**, who for the past two years had been studying the subject at the Dental Hospital in conjunction with Dr. W. J. Penfold, had found the *Entamœba gingivalis* in every case of pyorrhœa examined, some 300 in all. In fifty normal "controls," i.e. mouths in which no microscopic or macroscopic pus existed, they failed to find any amœbæ. They, also, found in the pockets another amœba, about 8–10 $\mu$ in diameter, which was obviously a free-living form. On staining by the iron-hæmatoxylin method of Heidenhain, the nucleus was seen to be different from that of the parasitic form, yet it showed no contractile vacuole, and therefore they were considerably surprised at being able to grow it (at a temperature of 37° C.). In culture it developed a contractile vacuole, but it was found that when the amœba was transferred in culture to strictly anaerobic conditions, the contractile vacuole disappeared, and the amœba reverted to the type originally found in the mouth. His co-worker and himself were in agreement with Mrs. Goodrich in disregarding amœbæ as the cause of pyorrhœa. In none of six cases at the Dental Hospital treated with emetine was there any resultant improvement, nor did the amœbæ disappear. The most noticeable feature in cases of pyorrhœa was the immense number of spirochætes. Whether Nogouchi was right in stating they were the cause of the disease he was not in a position to state, but they certainly merited investigation. Mr. Sheppard had said that the cause of pyorrhœa must not be looked for among bacteria, but rather in a systemic condition. That being so, he (the speaker) was at a loss to understand why Mr. Sheppard advocated vaccine treatment for the disease.

**Dr. Pixell Goodrich**, in reply, said that cultures of the *Bacillus fusiformis* were apparently only obtained with great difficulty; she and her collaborator had not started to grow it, but had seen it stated that it produced short filaments. Its identity with the spirochæte of Vincent's Angina had been put forward chiefly by Tunnicliff; Captain Bowman, at the Canadian Military Hospital, was also trying to make out that the spirochæte evolved into the bacillus, or *vice versa*. There was no evidence of pyorrhœa being caused by spirochætes; Nogouchi had grown *Treponema mucosum* which gave off the fœtid odour that some medical men insist is characteristic of pyorrhœa. But *Bacillus fusiformis* had been said to have the same smell, as also had the *Bacillus necrosus*.

With regard to a systemic or constitutional cause for the disease, of course if the system had run down, there was then a predisposition to the growth of organisms; but that did not negative the suggestions put forward by her colleague and herself. They had encountered one or two cases in which arthritis was present also. But pyorrhœa is so widespread a disease that it must be easy to find people in whom both

diseases co-existed: but that coincidence alone would not be sufficient reason for co-ordinating the two diseases.

As to the suggestion that smokers might be more free than others from pyorrhœa, she did not consider that smoke possessed any antiseptic properties. For protective or curative purposes a saturated solution of a mild antiseptic such as boracic acid used several times a day was much better than smoking.

With regard to Mr. Drew's observations on the presence of *Limax amœbæ* in the pockets, no doubt the cysts might sometimes open in the mouth as they did in the intestine occasionally, and in those cases probably the contractile vacuole would be lost. True parasitic amœbæ never had a contractile vacuole. The *Entamœba coli* and parasitic amœbæ were scavengers; they did not feed on the actual tissues.

**The President** said it devolved upon him to propose a very hearty vote of thanks to Mrs. Pixell Goodrich and Miss Moseley. The Society could not but feel honoured at being selected as the medium through which the results of their study of this subject had been set forth and published. Not only had the evening been one of intense interest, but the paper would be a contribution of great value in the Journal, in which it would appear *in extenso*. The vote was carried by acclamation.

---

**Mr. Scourfield** said it had been hoped that there would be a good show of living specimens belonging to the Volvocaceæ that evening, but during the last week or two nearly everything except *Volvox* itself seemed to have disappeared. The only living specimens on view were therefore representatives of the two common species of *Volvox*, viz. *V. globator* and *V. aureus*, and possibly a species of *Chlamydomonas*. All the others shown were mounted specimens Three very interesting exhibits had been sent by Professor G. S. West, viz. *Pleodorina illinoisensis*, *P. californica* and *Platydorina caudata*. The last-named, although nearly a flat plate, like *Gonium*, evidently did not originate as such, but had been evolved from an ellipsoidal form. This was proved by the fact that the cells alternated, one having the flagella pointing to one side and the next in the row pointing to the other side. Although the exhibition was not very extensive, he thought the specimens would show fairly well the close relationships which existed among this very interesting group of minute plants.

**The President** proposed that the thanks of the Society be tendered to Mr. Angus for the loan of the Microscopes under which the exhibits were placed, as well as to those Fellows who had contributed specimens; which was carried by acclamation.

---

It was announced that the meeting of the Biological Section would take place on Wednesday, November 1st, and to it Fellows were cordially invited, especially those who had recently joined, so that they might see what the biological work of the Society was.

The Society's next meeting would be on November 15th, when Dr. Singer would make a communication.

---

**The following Specimens were exhibited :—**

By Dr. Pixell Goodrich and Miss Moseley :—

Preparation of *Entamœba gingivalis* Gros., showing pseudopodia, nuclei and inclusions. (Stained iron-hæmatoxylin.)
Numerous *E. gingivalis* burrowing between the threads of leptothrix at the edge of a clump of tartar. (Iron-hæmatoxylin.)
Sections of cat's jaws with advanced pyorrhœa. (Various stains.)
Leptothrix branches of the "bottle-brush" variety casting off fusiform bacilli. (Iron-hematoxylin.)
A large branch from a clump of leptothrix. (Stained Stephens' ink.)

---

**Exhibition of Volvocaceæ :—**

| | |
|---|---|
| Mr. E. E. Banham . | *Chlamydomonas* sp. (?) |
| Mr. James Burton . | *Eudorina elegans.* |
| Mr. G. H. Gabb . . | *Pleodorina illinoisensis.* Sent by Prof. G. S. West. |
| Mr. J. Grundy . . | *Pandorina morum.* |
| Mr. W. Lauwers . | *Platydorina caudata* and *Pleodorina californica.* From Illinois; sent by Prof. G. S. West. |
| Mr. F. J. W. Plaskitt | *Volvox globator.* |
| Mr. D. J. Scourfield . | *V. globator* under $\frac{1}{12}$ oil-immersion lens, showing cells with protoplasmic connexions. |
| Mr. C. D. Soar . . | *V. globator.* |
| Mr. Geo. Tilling . . | *V. aureus.* |
| Mr. Joseph Wilson . | *V. globator.* |

## A SPECIAL MEETING

OF THE SOCIETY WAS HELD AT 20 HANOVER SQUARE, W., ON WEDNESDAY, NOVEMBER 15TH, 1916, AT 7.30 P.M., MR. E. HERON-ALLEN, F.L.S. F.G.S., ETC., PRESIDENT, IN THE CHAIR.

The Notice, dated November 3, 1916, convening a Special Meeting for the purpose of discussing a proposal to alter Bye-lays 76 and 79, by the insertion after "8 o'clock p.m." of the words "or at any such other time as the Council may appoint," having been read, and the result of a post-card vote on a proposal to alter the time of meeting to 5.30 p.m.—which was decidedly in favour of the earlier hour—having been declared, the President invited the opinion of Fellows on the subject.

A very animated discussion took place, in which many Fellows participated, as the result of which **Mr. Maurice Blood** proposed, and **Mr. Cuzner** seconded, the following amendment :—

> "That, so far as relates to the time of meeting, Bye-laws 76 and 79 be suspended for the duration of the War, and that the Society meet at 7 o'clock p.m."

The amendment having been carried, by a large majority, it was put by the President as a substantive motion, and was agreed *nem. con.*

The Meeting then adjourned.

## AN ORDINARY MEETING

OF THE SOCIETY WAS HELD AT NO. 20 HANOVER SQUARE, W., ON WEDNESDAY, NOVEMBER 15TH, 1916, MR. E. HERON-ALLEN, F.L.S. F.G.S, ETC., PRESIDENT, IN THE CHAIR.

**The Minutes** of the previous Meeting, having been circulated, were taken as read, and confirmed and signed by the President.

---

**The President** announced the following donations to the Society :—

| | From |
|---|---|
| Boyer, C. S., The Diatomaceæ of Philadelphia .. .. .. | *The Publishers.* |
| Stopes, M. C., Catalogue of the Mesozoic Plants in the British Museum .. .. .. .. .. .. .. .. | *British Museum.* |
| Cummings, B. F., The Louse and its Relation to Disease | *Ditto.* |
| Guide to the enlarged models of Insects and Ticks exhibited in the British Museum .. .. .. .. .. .. | *Ditto.* |
| Hanitsch, R., Malayan Blattidæ .. .. .. .. .. | *Captain Warrington.* |
| Van Heurck, H., Le Microscope aux études d'Anat. Vegétale .. .. .. .. .. .. .. .. .. .. .. | *Mr. F. E. Robotham.* |

He was sure it would be the pleasure of the Society to return thanks to these donors for their gifts.

---

**Mr. Sydney C. Akehurst** exhibited a New Tank, and Pond-weed Holder, for use with the Greenough Microscope, a full description of which appears in the Journal of the Society.

**Mr. Scourfield** said he had not yet had an opportunity of testing the apparatus, but the results Mr. Akehurst had kindly shown him were excellent. The method of immersing the objectives was extremely useful, as it gave a better idea of the solidity of the objects, and permitted one to actually see what was happening when following the free movements of organisms. He hoped this communication would stimulate competent workers to compute immersion lenses for this particular kind of work.

**Mr. Maurice Blood** did not think it would prove a difficult matter to have immersion fronts for dry lenses of the powers required if they were lenses of not too wide an angle. The apparatus was a very useful one, and possessed one special advantage: there would be no discussion as to who was the originator of "the tank."

---

**The President** said that, unfortunately, Dr. Charles Singer had been called away on military duty, and so was prevented from giving his paper on "The Microscopic Work of the Accademia dei Lincei." The paper would, however, be contributed on a future occasion.

---

**Dr. Hort** then made his communication on "Studies in Pleomorphism in Typhus and other Diseases," illustrated by a number of remarkable photomicrographs prepared and exhibited by Mr. Martin Duncan. The paper is printed *in extenso* in the Transactions. In the discussion that followed,

**Dr. John Eyre** confessed he had no practical experience of the organism associated by Rabinowitsch with typhus, but Dr. Hort's observations on the typhoid bacillus vividly recalled some work carried out fourteen years ago by a then colleague of his at Guy's, Dr. Pakes, on this organism, in which the typhoid bacillus cultivated in nitrate broth exhibited exaggerated pleomorphism, and forms were obtained very similar to those shown by Dr. Hort from the acid broth. At that date dark-ground illumination apparatus had not reached the present pitch of perfection, and neither the indian-ink method or the congo-red method was available. Those observations he referred to were carried out with the ordinary central stop under the condenser. At one time he himself used Rheinberg's colour disks. The interpretation he then placed on the peculiar appearances which Dr. Hort had demonstrated, after observations sometimes prolonged to many consecutive hours, was that the apparent branchings of the typhoid bacillus were not branchings at all, but were organisms crossing each other or lying one on top of the other; moreover, during the observation period the individual bacilli concerned could be seen gradually slipping one over the other. In reference to another of the appearances which Dr. Hort mentioned—viz. the bean-shaped arrangement, with a groove along its centre, and another with segmentation of its cell protoplasm—similar appearances were shown to the Society a few months ago by Mr. Barnard in "ultra-violet" photographs of the *Bacillus bulgaricus*. He (the speaker) was not prepared at the present moment to agree that this was necessarily sporulation, or division of spores, or anything of that kind; but it was an indication that Dr. Hort was seeing, in some of these pleomorphic

typhoid bacilli, suggestions of structure which it was the hope of every bacteriologist would be demonstrated at some future time.

**Mr. Maurice Blood** asked whether the slides which had been shown were negatives. He could not imagine they were dark-ground photographs.

**Mr. Martin Duncan** replied that they were all positives taken from negatives.

**Dr. Hort**, in reply, said he thought Professor Eyre's observations, in so far as deductions from hanging-drop observations were concerned, were extremely fair, and he was certain that Dr. Eyre was right in the simple apposition explanation in some forms of simulated branching. But Dr. Eyre was admittedly not familiar with the congo-red adsorption method, and if time allowed he hoped he would study the question by using acid-broth cultures emulsified with congo-red. After Dr. Eyre had worked on these lines for a few days he would be much interested to hear his conclusions, and he was sure that mere apposition would be found inadequate to explain the multiple evidence of fungoid growth, including dichotomous segmentation previous to sprouting. The only way, as he had already pointed out, of absolute proof was study of growth from single living organisms, taking photographs at intervals. He assumed, in conclusion, that complete evidence as to the true nature of the bacilloids and coccoids seen in the typhus, typhoid, and paratyphoid films would be regarded as sufficient to justify abandonment of the *bacterial* theory in these diseases.

**The President** said he was sure the Society would wish to tender to Dr. Hort its grateful thanks for the very illuminating and interesting address which he had given; and with that he would like to couple the name of Mr. Martin Duncan for the beautiful photographs which he had made and shown.

The vote was carried by acclamation.

---

**The following Apparatus, Specimens, etc., were exhibited :—**

Mr. Sydney C. Akehurst :—Tank, and Pond-weed Holder for Use with the Greenough Microscope.

Dr. Edward C. Hort :—

Typhus fever filtered blood (Chamberland F.). Eosin stain only :—

*Diplococcobacillus exanthematicus* Rabinowitsch, Plotz, etc. (Incubated 1).

Ditto ditto. (Agar culture from 2).

*D. exanthematicus* Rabinowitsch. (Acid-broth culture from 3).

Ditto ditto. Sporulating "bacilloids." (Agar culture from acid-broth.)

Typhus fever unfiltered blood :—

Blood culture showing minute coccibacilli and resistant bodies. (Unopened blood culture eleven weeks old.)

Spleen culture (ærobic) of Rabinowitsch.

---

**New Fellow** : The following Candidate was elected an *Ordinary* Fellow of the Society : H.H. Rajah Rohani Thirunal, Prince of Mavelikara family, F.R.Met.Soc., F.R.H.S. etc.

# INDEX

B

## D

## E

G

H

## I

J



K

## N

O

P

S

## U



## V

X



Y



Z



LONDON: PRINTED BY WILLIAM CLOWES AND SONS, LIMITED
GREAT WINDMILL STREET, W., AND DUKE STREET, STAMFORD STREET, S.E.